Concrete

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# Why?

NOT so long ago we had our inning at looking backward—over one hundred years of portland cement. Some fine speeches were made; interesting reminiscences were written and there was a general round of industrial self-congratulation which got everybody's mind momentarily off his own personal variety of trouble.

A natural reaction is the contemplation of the things we don't know and the achievements that *aren't*—yet. We don't need to go to the trouble of projecting the imagination into the dim and distant with its vision of things entirely new of which we haven't now the slightest definite notion. It is enough to ponder only those everyday riddles of experience—the whys and wherefores of the mysterious behavior of cement and concrete.

It has been mourned by a few that the entrance upon the engineering field of new cements—cements with special properties not looked for in the everyday portland—will upset the calm assurance of the public which can now buy a "standard brand" with the utmost indifference as to the name of the maker; upset also the calm assurance of the dealer—even the calm assurance of the maker himself, who rides along in the victorious train of concrete. He makes a cement that passes the "standard test" no matter what that standard test stands for in practice—no matter what that standard test yields in results in the hands of the laboratory men.

As a matter of fact, two score testing laboratories in which cement testing is an everyday matter take samples of precisely the same batch of cement and get results that vary 100%.

The cement user woke up several years ago to the fact that as among a dozen brands of portland cement—all passing the standard specifications—the strength results at certain periods, which to the builder may be critical periods, vary 100%.

On a job building a row of houses late last summer forms had to be removed after 24 hours to permit certain surface treatment. Three brands of cement were used, more or less interchangeably, with equally good results. In the fall when the temperature dropped below 50° two of the cements would still get hard enough in 24 hours to strip the forms as before while the third couldn't be used. Here then are three cements that are equal when the mercury is at 55° and not at all equal at 50°. Why?

In a big concrete brick plant the whole plant operation was nicely timed. After just so many hours of curing, products had to be moved, rather roughly. One brand of cement from one certain mill gave the best results. Other "standard cements" wouldn't answer at all. Why?

For years it has been the common thing to find a strong preference among products manufacturers for certain brands of cement. The preference was not due to a particular salesman's hand-shake or funny stories either; the favorite cement was less subject to crazing perhaps, or it attained earlier strength. The products man didn't know why his favorite brand of cement was best, but he knew it was best. Why was it?

Then there are other things we want to know about cement.

A manufacturer of ornamental concrete removing plaster molds for surface treatment after 24 hours breaks off an acanthus leaf; he sticks it back on again. With grout? No, just puts it firmly in place, applies hot water, holds the fragment securely and it knits on again like a bone in a ten year old boy. Why?

Some cylinders tested to their ultimate strength eight years ago, but not destroyed, stood outside along a wall until recently, when they were retested "just for fun"; they stood double the load put on them eight years ago. Why?

For years we were fed up on the idea that portland cement concrete and mortar must not be retempered; it was somewhere near the top in all the lists of don'ts; yet here and there an old-timer, some rule of thumb workman who learned it from his father, used a retempered mix for a patch or for a door-step which was to be hard trowelled and smooth. Now we know the old-timer was right. Remixing after three or four hours is a good thing. It tends to eliminate crazing and shrinkage. Why?

A good deal has been—still is—said for finer grinding. Yet to the finest of the cement—the flour— are attributed many evils—excessive laitance, excessive shrinkage, flash set, and little strength.

Thaddeus Merriman in finding a cure for surface shrinkage flooded part of a bucket of cement, stirred and washed it and poured off the fine stuff. The coarse cement, mixed up in a mortar gave no visible shrinkage cracks when cured in the sun. Why?

This matter of cement is full of interrogation. We fill a page with confessed ignorance merely with the thought to encourage observation—as discriminating as possible—of what happens under varying conditions and with various cements on the job. In time we may know why.

So we can't look with any great alarm on the early possibility of having many different cements, each one recommended for a special use. This may be a little bewildering but it is sure to encourage a study of special characteristics and properties. It can't be much more bewildering than the variable results obtained with so-called standard cements which are standard enough for the not too exacting requirements of some jobs and leave off being standard below or above a certain temperature or maybe between three and five on Thursdays.

# The High Cost of Housing

John M. Gries contributes a paper, "Housing in the United States," to *The Journal of Land and Public Utility Economics* which surveys the housing needs and its tendencies, good and bad, many of them pointing to an increasing future demand for better building. Following are excerpts from Mr. Gries' paper:

Probably 95% of all rural dwellings are made of lumber—commonly known as frame houses. Judging from estimates obtained by the Division of Building and Housing of the Department of Commerce from nearly a thousand villages and cities having a population of more than 2,500, more than 75% of all urban dwellings in the United States were also constructed of lumber. Brick, stucco, tile, and stone houses show smaller percentages. While these percentages cover the houses already in existence, they in no way indicate the ratio of the different classes of houses now under construction. The figures are most striking in that they show the great difference bwtween the houses in the United States and those in most European countries.

Despite the great building activity since 1922, a number of elements in the situation show that the road to further improvement is not fully cleared. As might have been expected, during the periods of shortage the needs of those best able to pay for new houses were met first, and what relief has come to the lower income groups has been through relief of pressure at the top, permitting families with lower incomes to move up into quarters vacated by those better off financially. High costs have led in some cases to sacrifice of quality of materials and workmanship in order to reduce expenses. A greatly increased number of multi-family houses has been erected recently. A disproportionate number of row houses has also been built, and, in fact, any type of house which could be produced cheaply has been constructed regardless of the fact that some have not met with reasonable housing standards.

While some buildings last for centuries, others are destroyed or torn down within a few years. A dwelling, with reasonable maintenance, should last for 50 years at least, and if our cities are well planned, there is no reason why more residence sections should not remain intact for many years. In such areas, temporary or shoddy construction is the most expensive. However, structures are frequently needed for temporary purposes, as in mining and lumber sections where other industries are not expected to come in when the mine has been exhausted or the timber has been removed.

The construction industry is not efficient when taken as a whole. There are too many different groups which contribute only a small part of the material or work going into a house, and too often each group feels no direct stimulus to seek means of reducing the cost of its part of the material or work, a cost which is very small in comparison with the total cost of the building. The market for houses would be greatly increased if waste could be eliminated all along the line.

Under the present organization of labor more than a dozen skilled trades may be employed on the erection of even a small dwelling. Not many decades ago practically all work was done by four skilled trades. Most houses were built of wood and the carpenter was the principal skilled workman. He was not only skilled in framing but was probably also a skilled floor layer, roofer, and door-hanger. Today work is widely subdivided and the scheduling of work is most difficult for the small builder. There is not only the general contractor but often also subcontractors employed by him to complete a group of small houses.

In short, the building industry is not conducted on the factory system. There is little satisfactory routing or scheduling of materials. By way of comparison, in the automobile industry each of a large number of companies produces many thousands of cars, but in the building industry probably 75% of all the single-family houses are built by contractors erecting fewer than 10 houses annually. These homes are frequently scattered over a large area, making it difficult to schedule both materials and work. There are, of course, a few large operators who build several hundred houses each year and are able to schedule their work according to modern methods of production. If the conditions in the automobile industry were similar to those in the building industry, the manufacturer would build two automobiles on Broadway, two in Yonkers, four in Brooklyn, and two in the Bronx. There would be at least three different models, the spokes and metal would be cut on the job, three different types of engines would be used, and all purchases and deliveries would be in small quantities. Mass production would be impossible.

Another deficiency is found in the great variety of building material specifications. Is there any need for 30 or 40 different sizes of brick? Why are bathtubs made in 30 different sizes? Could we not get along without many hundred different sizes and styles of window sash? This lack of dimensional standardization of building materials is a considerable element in the high cost of such materials.

The irregularity of building activity has often been the subject of comment. For many years it was customary for building to proceed actively during six or eight months and practically come to a standstill during cold weather. The peak in building operations has required an excessive amount of equipment in the hands of the contractor to take care of the peak and some of this equipment remained idle during the greater part of the year.

During the recent active building period a shortage of skilled labor developed, manifesting itself chiefly among the plasterers and brick masons. Although building trade workers are employed by the day, they must live throughout the year; hence the wage scale is not as important to them as the length of the building season. In order to induce young men to enter the skilled trades as apprentices it is necessary to show that the building season can be lengthened, for few men care to enter a trade which normally provides fewer than 200 working days per annum. Some of the contractors claim that the unions have arbitrarily limited the number of apprentices in order to maintain a scarcity of skilled labor. The labor leaders, on the other hand, say that their organizations have not restricted the number of workmen in trades but that contractors usually decline to accept more than a very few apprentices and some refuse to employ any apprentices whatsoever.

Consider also the financing of contractors! As a rule contractors and operative builders are financed largely by banks. As long as the market for houses is good, the builder, with a relatively small amount of cash, can obtain sufficient funds to finish each job. During the past few years the contractor has frequently discounted the second-mortgage note in order, in this way, to secure added cash which could be used on the next job. Thus, although money was available for contractors, the commissions and bonuses demanded were especially high during the recent shortage of money.

# Demolition of Heligoland

The demolition of Imperial Germany's fortress of Heligoland is to a considerable extent the destruction of very substantial concrete. *Le Genie Civil* says:

Heligoland is not a large island—it is only about a mile long and 550 yards wide—and has steep cliffs on all sides. The sole means of access are two stairways cut in the cliffs, and an electric lift.

The massive fortifications include a port capable of holding 150 submarines at once. The 120 cannon of various calibres were placed in much the same positions as on a man-of-war, and the island was provided with a wonderful network of tunnels which gave complete access to every gun.

Concrete has been used in very large quantities for the protection of the guns, both mass and reinforced concrete being used.

Two observation posts, one at the north and the other at the south end of the island, were connected by means of a tunnel 7 ft. high, the roof of which was formed of reinforced concrete at least 5 ft. thick.

The superstructure of each turrent for the 305 mm. guns had three platforms, and a very strong and thick cylinder of reinforced concrete at its base.

The smaller ordnance was protected by concrete 10 ft. thick, the same thickness being adopted for all parts of the fortress subjected to direct fire.

The greater part of the submarine harbor was covered so as to make it invisible to an attacking force. The portions of the jetty built at a small depth were composed of large blocks of concrete, the deeper portions were built on caissons of concrete, each 83 ft. long, 33 ft. wide and 33 ft. high. They were built on the shore, floated to the proposed site and there sunk by filling them with concrete.

The destruction of the fortifications is now proceeding. The concrete works and the tunnels are being destroyed by dynamite, the machinery is crushed to pieces and the cannon are cut up by means of oxy-acetylene lamps. The port will be completely destroyed, but it is estimated that two years will be required for its destruction. Breaches are also being made in the various parts of the works most exposed to the sea, so that the latter may aid in the destruction.

# Concrete Paving Units

## *A Comparison of Their Efficiency*

*By W. W. Zass*
STATE HIGHWAY DEPT., LITTLE ROCK, ARKANSAS

It is often quoted that contracting is nothing but a gamble, that competition is too keen and that prices are too low. This statement is true perhaps to some extent, but does it apply to contracting only? An analysis of any line of business will show that it is more or less of a gamble. The merchant lays in a stock of goods and gambles that he will sell it, the barber equips a shop and gambles that he will receive custom, the meat-packer buys beef on the hoof, slaughters it and gambles that he will dispose of the finished product, the worker gambles his strength and skill on the labor market against the fear of unemployment. Life, itself, is the biggest gamble of all; we know not what awaits us in the way of sickness or accident or the reward of labor.

Contracting probably numbers among its ranks as many incompetent and ill-advised starters as does any other profession or business, perhaps more; however statistics show that the percentage of failures in all lines is great, that the factors of lack of capital and insufficient knowledge of the business in question, coupled with uncontrollable contingencies prove to be hazards that 85% of those who engage in business are unable to survive. In contracting as in other lines of business the element of uncertainty, the gamble, is reduced to a minimum by an intimate and extensive knowledge of the work involved. This element cannot be eliminated entirely but it can be confined within certain limits.

A contingency which benefits one line of business may injure another. As witness, a spell of wet weather may injure the contractor engaged in outside construction work while on the other hand it would materially assist the merchant engaged in the retailing of rubber goods, whereas a dry spell which would materially affect the sales of the merchant would prove of inestimable value to the contractor. The more common of the contingencies affecting contracting may be classified as those delays due to inability to obtain materials, due to car shortages or other causes; those delays due to inability to obtain and hold labor; and those delays due to weather conditions. Any of the aforementioned factors would vitally affect the cost of the work and should be included as a part of the cost of the work, to the degree that experience or observation indicates advisable.

Those engaged in obtaining construction work on a competitive basis are faced with the alternate of so quoting their price on the work that it will be sufficiently high to insure them a profit, while on the other hand the price quoted must be sufficiently low to enable them to underbid their competitor. In order to meet this medium close figuring or estimating is necessary, and even then the job may go to a competitor who guessed at rather than analyzed his estimated costs.

Of some twenty-six contracts let for highway work in a southern state in 1924, 134 bids were received, or an average of 5.2 bids received to each contract let. This average would indicate the need of a close analysis of costs for each job on the part of the contractor if a fair share of the work is to be obtained by him. Such an analysis would tend to place costs into different groupings; broadly speaking, three groups would serve. Into one group could be placed those items of cost which may be classed as non-fluctuating, costs on which you could expect no variations during the life of the work, such as freight rates or prices quoted by dealers on materials or supplies. Into another group could be placed those items of cost which may be classed as standard or prevailing costs, costs which are not fixed but which can be calculated within a reasonable degree of exactness such as wage rates in a certain locality, or the output per day for a certain kind of labor. Into the third group could be placed those items of cost which may be classed as contingent costs, costs which are uncontrollable in their entirety, but which can be estimated for any given time or condition with a reasonable degree of certainty, through experience and close observation, such as delays due to weather conditions, or delays caused by labor shortages.

This ability to size up a certain situation and estimate the cost of the probable contingencies upon it, as well as to decide upon the character and extent of the equipment needed to complete the work successfully, might be likened to the capital in trade of the party in question. Very often too little attention is devoted by contractors to the selection of equipment for the specific work it is intended to perform. This might be cited as an example of lack of experience or a failure to capitalize such experience. It is evident that if the equipment is unbalanced, inadequate or oversize that the efficiency of the unit will be impaired, resulting ultimately in a loss of either actual or potential profits.

Upon every class of construction work there is one piece of equipment that is the controlling factor in the progress of the work. As for example, no more dirt can be taken from an excavation job than the steam-shovel can handle, regardless of the number of trucks or other carriers waiting upon it. The capacity or output of a trench excavator limits the linear feet of pipe that may be laid in a certain length of time. No more material can be fed to a concrete mixer than it will turn out, regardless of the quantities of materials that may be transported to it.

In concrete road work a careful study of the potential work might tend to show that a number of smaller outfits would prove more economical than one larger outfit. It might also tend to illustrate the most adaptable method of transporting materials to the mixer, and the question of mobility of equipment would necessarily be needed to be considered, as well as its adaptation to some future piece of work. While it is true that under theoretically ideal conditions an 8-sack mixer will lay double the number of square yards of paving in a given time as will a 4-sack mixer, or four times as many as will a 2-sack mixer, it is equally true that such a ratio will not exist unless all the factors coincident with the paving operations are properly coordinated.

There is a lack of reliable data concerning the actual performances of paving units. The actual working time of a mixer over an extended period of time is but a small percentage of the total elapsed time for that period. A reliable analysis of the operations of different units over several seasons of operations should prove of interest and value to those engaged in concrete road work, both engineers and contractors. Such data cannot be used without discretion, but it can be made to serve as a criterion to be guided by.

An unusual opportunity for such an analysis was offered on a 61-mile paving job in Phillips county, Ark., extending over a three year period. The work in question was handled through the preliminary stage and to completion by L. R. Parmelee, practicing civil engineer, of Helena, Ark. and consisted of a one course concrete pavement, 14 ft. wide and of a 6-in. uniform thickness. A 1:2:3 mix was used and the specifications called for the aggregates to be revolved in the drum of the mixer a full minute. No unusual methods were employed upon the work nor were any unusual difficulties encountered. Negro labor was employed, with white foremen and mechanics. All concrete materials were shipped in by rail and considerable difficulty was experienced in 1921 and 1922 in obtaining sufficient supplies to carry on the work. In 1921 Outfit No. 4 operated over a gumbo subgrade, the balance of the outfits for this season operated over a light sand mixed soil. In 1922 and 1923 outfits excepting Outfit No. 2 operated over a gumbo subgrade.

From the beginning of the paving operations Mr. Parmelee had recorded in detail the result of each days operations for each mixer in service. When the job was completed these daily report cards were tabulated and the various data compiled into its different divisions. During the first season's operations there were five mixers in service, during the second season there were three and during the third season there were two. One inspector was stationed with each outfit, who was chargeable, among other duties, with obtaining and recording the data in question. Table A shows in detail the performance of the various outfits throughout the three year period. An explanation of the various headings may serve to make the table more clear.

"Actual Running Time of Mixer"—Time during which concrete mixer was operating, computed in hours and fractions thereof.

"Mixer Delays"—Shutdowns or cessations due to trouble with mixer, with water line or with pump.

"Material Delays"—Inability to operate mixer due to shortage of concrete materials, i. e., failure of dealer or railroad to deliver.

"Changing Setup"—Shutdowns due to necessary move of mixer or supplementary equipment.

"Weather delays"—Inability to operate mixer due to snow, rain, frost or wet sub-grade.

"Labor Shortage"—Inability to operate mixer through not having a sufficient crew.

"Carrying Delays"—Inability to operate mixer due to derailments, truck breakdowns, or other failures to deliver materials from railroad siding to mixer.

"Total Days in Working Season"—Computed from the date fine grading operations and form setting started and mixer was on the ground until the end of the job or until concreting operations ceased in the fall. Time used in stockpiling during the winter or spring months not included.

"Efficiency Rating"—Square yards of paving laid per hour of actual running time divided by the number of sacks of cement used per batch of concrete.

Table A can be further condensed and sub-divided as shown in Table B, the delays being classified as "calculable delays" and "contingent delays," all percentages being in relation to the working season.

Table B

| | | | | |
|---|---|---|---|---|
| Mixer in Actual Operation | | 32.8% | | 100 |
| Calculable Delays | Sundays and Holidays | 14.1% | 21.4%—54.2% | |
| | Changing Setup | 7.3% | | |
| Contingent Delays | Breakdowns | 8.1% | 45.8% | |
| | Material Shortages | 19.8% | | |
| | Labor Shortages | 5.3% | | |
| | Weather Conditions | 12.6% | | |

An analysis of Table A and Table B indicates that on this piece of work, 10 mixer seasons, the mixer was in actual operation only about one-third of the working season and that this working season comprised only one-half of the entire year. Following out this line of reasoning we find that for the yearly period the mixer would be working on the average of about only one day in six. With the mixer idle, the greater percentage of the supplementary equipment would necessarily remain idle, thus practically tying up the entire investment. If the equivalent cash value of such equipment was

Table A

| | Per Cent of Working Season | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual Running Time of Mixer | Mixers Delays | Material Shortages | Changing Set-Up | Weather Delays | Labor Shortage | Carrying Delays | Sundays and Holidays | Total | Total Days In Working Season | Total Hours In Working Season | Working Season In Per Cent of Entire Year | Square Yards of Paving Placed | Square Yards per Hour of Actual Running Time | Efficiency Rating Square Yards per Hour of Running Time per Sack Rating | |
| 1 Outfit No. 1—8 Sack Mixer —Industrial Ry.—1921 | 40.6% | 2.3% | 18.3% | 6.5% | 14.3% | 1.2% | 3.3% | 13.5% | 100% | 255* | 2550 | 70% | 96600 | 93 | 11.6 | 1 |
| 2 Outfit No. 1—8 Sack Mixer —Industrial Ry.—1922 | 25.2 | 1.9 | 28.6 | 5.6 | 16.8 | 7.0 | 1.0 | 13.9 | 100 | 173 | 1730 | 47 | 44020 | 101 | 12.6 | 2 |
| 3 Outfit No. 1—8 Sack Mixer —Industrial Ry.—1923 | 27.6 | 3.2 | 1.5 | 8.6 | 32.8 | 6.8 | 4.8 | 14.7 | 100 | 163* | 1630 | 45 | 44705 | 99 | 12.4 | 3 |
| 4 Outfit No. 2—3 Sack Mixer —Industrial Ry.—1921 | 26.6 | 1.4 | 31.7 | 6.6 | 6.0 | 10.2 | 3.5 | 14.0 | 100 | 229 | 2290 | 63 | 36021 | 59 | 19.7 | 4 |
| 5 Outfit No. 2—3 Sack Mixer —Industrial Ry.—1922 | 20.4 | 0.9 | 45.2 | 4.0 | 6.0 | 5.0 | 5.1 | 13.4 | 100 | 179 | 1790 | 50 | 25403 | 70 | 23.3 | 5 |
| 6 Outfit No. 2—3 Sack Mixer —Industrial Ry.—1923 | 38.8 | 9.5 | 6.2 | 8.8 | 13.9 | 2.6 | 5.2 | 15.0 | 100 | 120* | 1200 | 33 | 29448 | 63 | 21.0 | 6 |
| 7 Outfit No. 3—4 Sack Mixer —Truck Haul—1922 | 35.5 | 12.4 | 8.1 | 11.1 | 7.9 | 10.2 | 1.2 | 13.6 | 100 | 81* | 810 | 22 | 25683 | 90 | 22.5 | 7 |
| 8 Outfit No. 4—4 Sack Mixer —Truck Haul—1921 | 47.3 | 3.9 | 11.0 | 6.5 | 13.6 | 1.5 | 1.4 | 14.8 | 100 | 195* | 1950 | 53 | 74916 | 81 | 20.2 | 8 |
| 9 Outfit No. 5—4 Sack Mixer —Truck Haul—1921 | 32.0 | 4.2 | 25.2 | 13.0 | 10.0 | 1.2 | 1.2 | 13.2 | 100 | 225 | 2250 | 62 | 68301 | 95 | 23.8 | 9 |
| 10 Outfit No. 6—2 Sack Mixer Materials Stocked on Subgrade—1921 | 33.7 | 14.4 | 22.0 | 2.7 | 4.5 | 7.7 | 0.4 | 14.6 | 100 | 177* | 1770 | 49 | 29811 | 50 | 25.0 | 10 |
| Averages | 32.8% | 5.4% | 19.8% | 7.3% | 12.6% | 5.3% | 2.7% | 14.1% | 100% | 179.7 | 1797 | 49.4% | | | See Note Below | |

Note: At one Batch every two Minutes output would be 29.0 sq.yds. per hour per sack rating.
" " " " three " " " " 19.4 " " " " "
" " " " four " " " " 14.5 " " " " "
" " " " five " " " " 11.6 " " " " "
1 sq. yd. of pavement=0.1666 cu. yds. of concrete.

*Denotes that work on section was finished.

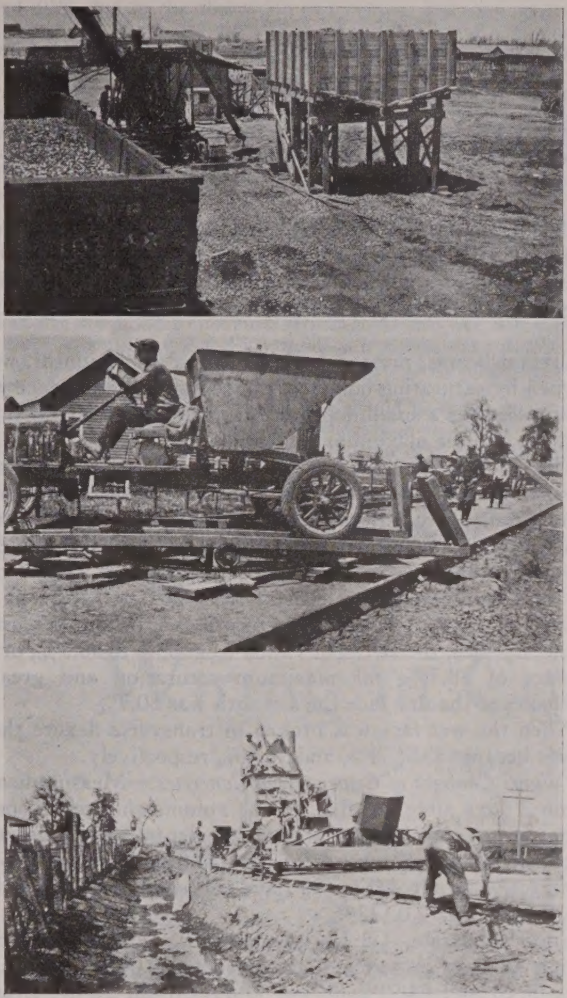

*Fig. 1—Some of the Elements of Outfit No. 4*

drawing interest only two months out of the twelve the owner would quickly seek a more lucrative investment. It is true that Table B is based on averages, but the maximum from which the table was compiled, Table A, showed that the "Actual Running Time of Mixer" was less than 50% of the working season or 25% of the entire year.

The average "Efficiency Rating" or average output, per sack rating, of the concrete mixers was 19.2 sq. yds. of pavement per hour, or an equivalent of about one batch of concrete every three minutes of actual running time. It will be noted that the 2, 3 and 4-sack mixers ran a little above this average while the 8-sack mixer ran considerably below. The principal cause of the 8-sack mixer falling below the standard is attributable to the fact that it was too large for the type of road in question, it was almost continually on the move, each batch produced paved 5 lin. ft. of roadway; also the weight of the machine was such as to make it necessary to use running planks which were always a source of annoyance and minor delays. There was also a host of other small delays attached to the big mixer on this type of work which apparently did not affect the smaller mixers. It is apparent from Table A and from practicable observation that it is most unlikely that more than 25 batches per hour can be expected under specifications which call for a full minute mix, and that in all probability the average will fall somewhat below that figure.

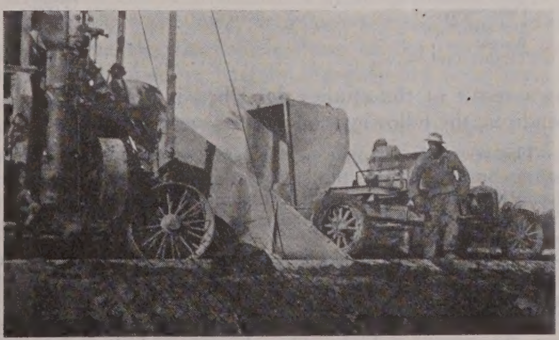

*Fig. 2—Outfit No.5. Reinforcing ready for placing*

The contingent delays as shown on this job are somewhat high, especially in regards to the materials item. However by noting the analysis of Outfit No. 1, 1923 (Table A) we find that material delays for this working season were very small while the weather delays for this same season were far above the average. This latter was due in part to the fact that the subgrade was a gumbo soil which could not carry the weight of the heavy mixer, unless thoroughly dry. The labor delays are somewhat above normal as the shutdowns due to material delays disorganized the crews and made it difficult to retain a full complement for use when needed. Material delays, of course, can be cut to a minimum by winter stockpiling of materials, where space for such stockpiling is available and the opportunity exists. Weather delays are variable on every job, however a considerable percentage of such delays is dependent upon the class or type of soil of which the subgrade is composed. A light sandy soil can be worked on almost immediately following a rain, while a rain upon a heavy gumbo or buckshot soil might delay operations for a day or more. Delays caused by breakdowns of equipment are difficult to anticipate and are contingencies which can be held to a minimum only by thorough supervision and inspection of the operating equipment.

Of the calculable delays—Sundays and holidays we have always with us. The item of "Changing Setup" can be estimated very closely when the work is figured on, some change in plan might become necessary after the work was in progress due to unavoidable circumstances, but such later changes would probably differentiate but slightly from the original layout.

As stated previously there is without question an element of risk, or gamble, attached to most pieces of construction work. This risk, or gamble as it might be called, varies as to the class and magnitude of the work. A thorough knowledge of the various factors or contingencies of which this risk is composed is essential if such risks are to be reduced to a minimum.

This required knowledge is obtainable through experience. The word experience is defined in the dictionary as "skill or practical wisdom gained by personal knowledge, feeling or action." A broad conception of this definition would include the knowledge gained by others and disseminated for general information, with the knowledge arrived at by the individual through his own efforts. Those engaged in the business of contracting who supplement their own experiences with the reliable recorded experiences of others will do much toward taking the gamble or contingency from their line of work.

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Various methods suggested by contractors for interesting superintendents and foremen in accident prevention include requiring frequent inspection by superintendents and foremen on the job; the posting of cartoons from the National Safety Council; putting superintendents and foremen on a bonus basis; asking superintendents or foremen how accidents reported can be prevented in the future; placing a definite item in the superintendent's budget for accident prevention; circulating reports from one job to another where superintendents know each other; and sending a summary report monthly giving a rating to the job similar to the system used in school report cards.

# The Effect of Moisture on Concrete

In a paper presented by W. K. Hatt, at the meeting of the Highway Division of the American Society of Civil Engineers investigations conducted by the Engineering Experimenting Station of Purdue University in cooperation with the U. S. Bureau of Public Roads are reported and the literature on the measurement of the volume changes in portland cements and concretes reviewed. A primary purpose of the investigations was to measure the maximum warping and surface deformation produced in a concrete road slab as the result of a non-uniform distribution of moisture to give a basis for estimating possible initial stresses. The tests also yield data of expansion and contraction of concrete, useful in the design of concrete structures.

The investigation was divided into two sections, namely, (1) observations on a concrete road slab, 7 in. thick, 18 ft. wide and 25 ft. long, resting on a porous subgrade, covered with a tent and housed in a shed to control the distribution of moisture and the effects of temperature; (2) tests of strength and length changes of small beam units, some partly and some uniformly saturated.

After curing under water, the slab was dried by circulating air both above the slab and through the subgrade. The more rapid drying of the top surface warped the slab to a maximum upward deflection of 0.12 in. at the corners and 0.04 in. at the unbroken edge during a period of 40 days, after which time upward movement ceased, the shortening of the diagonal being 0.0075%. After 3 months of further drying the slab had become approximately uniformly dry throughout its depth and substantially level with a diagonal shortening of 0.0210%.

In order to saturate the bottom of the slab, water was then introduced to the level of the top of the gravel subgrade. During 110 days of saturation, the slab again warped upward 0.20 in. at the corners and 0.066 in. at the unbroken edge. Simultaneously, a diagonal shortening of 0.0070% took place in the top face of the slab, of which 46% took place in 2 hours and nearly all in 2 days.

The shortening was caused by the expansive force of the saturated lower part of the slab, and occurred without a change in moisture content or temperature of the top layers. Assuming an elastic condition and a modulus of elasticity of 5,000,000 lb. per sq. in., a compressive stress of 350 lb. per sq. in. in the top is indicated. The level of the water was finally raised, but the concrete at the bottom apparently had become impervious and no further warping occurred. Then the surface was covered with saturated burlap to stimulate the effect of prolonged rain.

Daily changes in the temperature of the slab resulted in differential warpings, depending on the degree of saturation and the temperature gradient. A typical daily change in air temperature above the slab of 42° F. resulted in a variation of 3° F. from top to bottom of the slab. The accompanying downward deflection of the corner due to this warping was 0.023 in., and the expansion of the surface, 0.0015%. The movements due to this warping may be compared to 0.20 in. deflection and a shortening of 0.0057% due to the saturated subgrade.

Loading tests were made on the corner of the slab for three conditions of warping.

*The Beams.*—Tests were conducted on concrete beams 4 in. x 7 in. x 4 ft.: some were uniformly wet, some uniformly dry, and some warped by non-uniform moisture distribution. The transverse strength was determined for dry, saturated, and partly saturated beams.

Beams uniformly saturated had a strength ranging from 80 to 85% that of dry beams, the average value being 82.0%. Compression tests of wet concrete cylinders exhibited a strength of 75 to 83% that of dry cylinders, the average being 79.0%.

Certain beams, previously dried from 3 to 4 months, were warped by saturating one face. In so doing the dry face was compressed for a small depth of saturation, and extended for medium and for maximum saturation.

The dry face was tested as the tension face in a transverse flexure test. The variations in transverse strength for these various moisture conditions have been expressed in percentage values, 100% representing the completely dried specimens. The beams having a low depth of saturation and a shortened dry face exhibited a strength of from 109 to 127%, or an average of 118%; for medium saturation and slight extension of the dry face, the strength varied from 83.6 to 96.5%, or an average of 88.7%; for maximum saturation and greater extension of the dry face the strength was 80.7%.

When the wet face was broken in transverse flexure these values became 83.5, 71.3, and 76.6%, respectively.

*Volume Changes of Cements and Concretes.*—Measurements, begun 2 days after molding, of the volume changes in specimens of several brands of neat cements varied greatly. Expansion in water during 10 days was from 0.03 to 0.056%. Contraction in air during 90 days subsequent to immersion was from 0.052 to 0.142%.

Gravel concrete, 1:2:3½ (Cement F), expanded 0.005% during 40 days in water, and contracted 0.041% during 90 days in air and 0.050% during 30 days in an oven. Gravel concrete 1:1½:3 (Cements A and D), expanded 0.005% in water and contracted 0.015% in air and 0.0225 in the oven during the same periods.

In these studies of the changes of shape of concrete road slab the following matters were examined:

1.—The maximum distortion (including deflection and fiber deformations) produced in a concrete road slab 18 ft. wide, 25 ft. long and 7 in. thick by a non-uniform distribution of moisture.

2.—The effect of moisture changes on the modulus of rupture and compressive strength of concrete, determined by subsidiary tests on (1) beams 4 in. x 7 in. by 4 ft., and (2) cylinders 6 in. diam. x 12 in. long.

3.—The volume changes in the concrete beam specimens due to exposure, including warping due to partial saturation.

The approximate number of observations involved in the entire study was:

| Type | Number |
|---|---|
| Deformation | 40,000 |
| Deflection | 3,000 |
| Strength | 600 |
| Weight | 1,000 |
| Temperature | 1,500 |

As a result of the studies described in the paper and its appendices, the following conclusions were reached:

1.—The strength of concrete, like that of wood, varies with its moisture content. While the law relating to moisture content and to strength was not determined throughout various ranges of moisture content, it appears that saturated concrete will have 80 to 85% the strength of dry concrete.

2.—The thermal coefficient of expansion of concrete varies with the temperature of the concrete ranging from .0000040 at 65° to .0000060 at 140°.

3.—Concrete expands when immersed in water and contracts on drying. The degree of change of length varies with the characteristics of the brand of cement, with the richness of the mix, with the size of specimen, and with the conditions of exposure. Measurements begun after the initial hardening of the cement show that concrete may expand .01% due to the absorption of moisture, and may contract .06% when exposed to dry air. These changes continue. To these values should be added the changes in length during the initial setting of the cement.

4.—Concrete road slabs warp upward at the corners and at the edges when the surface becomes dry, and also when the bottom absorbs moisture from the subgrade. Drying the top surface of the slab under observation deflected the corners upward of .02 in. When the bottom of the slab was saturated from a water filled subgrade the upward corner deflection reached 0.20 in.

5.—This curling upward of the corners of the road slab presents a cantilever beam to the load of a passing truck. The results of the tests indicate the presence of an initial stress in the surface of the road slab arising from the warping.

6.—A combination of shrinkage from drying and from a fall in temperature will produce maximum shrinkage strains. A combination of a drop in temperature and a rainfall may retain the concrete at its previous length. The friction of a road slab on its subgrade is an element favoring the production of cracks.

7.—To be durable, concrete structures should be designed for the least favorable conditions. Stresses arising from the effect of temperature and moisture as well as those due to dead and live loads should be considered.

8.—Without careful curing concrete masses will undergo excessive surface shrinkage against their rigid cores, thereby favoring surface cracks. Therefore steel reinforcing should be placed near enough to the surface to withstand these shrinkage strains, and at the same time far enough below the surface to be protected against corrosion.

9.—The foreign experiments cited show the benefit of early and careful curing of concrete in reducing final shrinkage. The greater part of the shrinkage of mortar specimens took place in the first ten hours. These foreign experiments also show the greatly increased shrinkage of mortar mixed with an excess of water.

10.—Since the results of measurements of expansion vary with several factors, such as the size of specimen, the time of initial measurement, and the exposure, the method of such tests should be standardized.

The writer believes that the following are the requirements for concrete structures exposed to the weather:

(*a*) A portland cement of normal volume constancy and a clean, well graded aggregate.

(*b*) An impervious concrete of proportions not less than 1:2:4.

(*c*) A time of mixing of not less than 1 minute and preferably 1½ minutes for the production of uniform concrete.

(*d*) A concrete mixed with a minimum amount of water appropriate to the work at hand.

(*e*) Careful slicing of this dry concrete against the face of the forms so that the reinforcing steel may not be exposed nor the surface require patching.

(*f*) Early curing begun just after the initial set and continued for a time depending on local conditions.

(*g*) Design of reinforcing steel and contraction or expansion joints to prevent cracking and the entrance of water.

# Wiring in Concrete Buildings

## *Without Rigid Conduits*

One of the interesting features of the new Edison service building at the southeast corner of 41st St. and Fifth Ave., New York City, is the method of distributing electricity to the thousands of outlet points. Over a quarter of a million feet of wireway, ranging in diameter from one half to four inches, was required and in the entire system there is not a single foot of rigid conduit, the wires being run through ducts in the concrete. A series of holes running through concrete floors ceilings and walls constitutes the simple and efficient distributing agency, a new medium known as the Murray conduit system which bids fair to produce marked and radical changes in the practice of wiring certain classes of new buildings.

The building, a reinforced concrete structure, is ten stories high on an avenue frontage of 115 ft. and runs back to a depth of 414 ft. on East 41st St., occupying in the aggregate more than a half city block.

As described in the *Edison Monthly*, the basis of this unique wiring system, the first successful change of so fundamental a nature that has been introduced since ducts for electric light and power wires were incorporated in the structure of buildings, is the use of a gum tubing known as Murray conduit tube. Tubing of suitable diameter is first laid where the duct is specified on the wiring plans.

The floor space has been so arranged that it will care for the varied activities of a number of departments of The New York Edison Co. The lower floors are devoted largely to the garaging of the electric vehicle fleets of the company, full provision being made for battery charging and other services to keep the cars in the pink of operating condition. Space here is also provided for the storage of heavy materials and, to facilitate their moving from place to place, electric cranes and other machinery-handling equipment have been installed. On other floors are located the stationery, meter and test departments, together with numerous store rooms. A spacious and modern cafeteria, as well, will be installed for the convenience of not only the employees of the building, but also for the operating forces in the great Waterside generating stations just across the street.

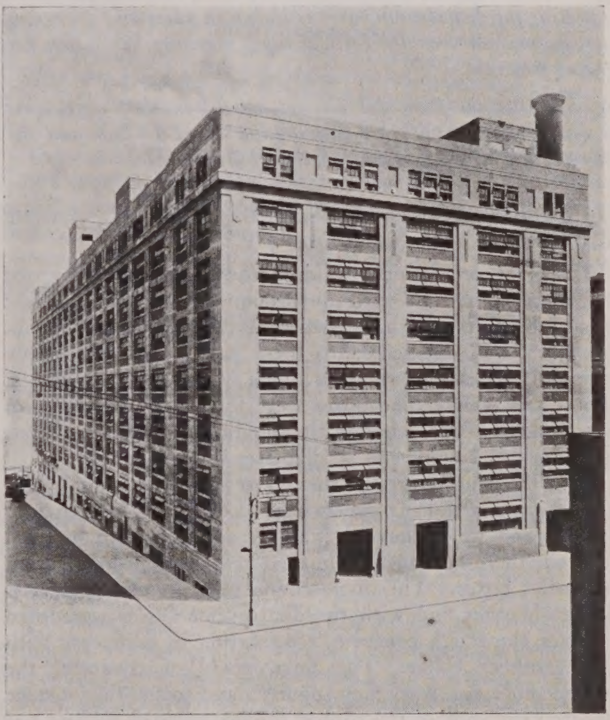
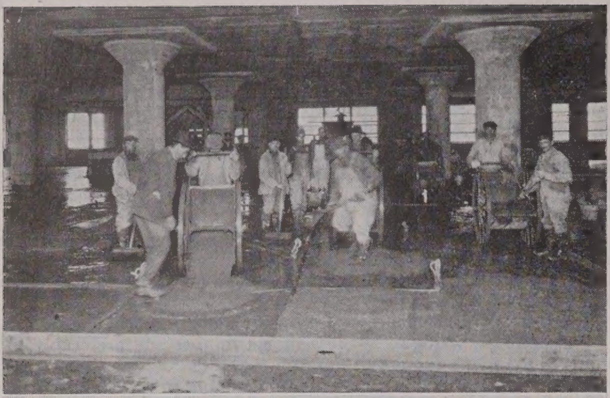


*Fig. 1—New Edison Service building at First Avenue and 41st Street, New York City, in the shadow of the Great Waterside generating plants. It will house several of the most important activities of the New York Edison Co.*

That the varied activities of this new building may be carried on with dispatch and the utmost efficiency, an electric wiring installation capable of supplying five thousand 200-watt lamps, 650 h. p. in motors and 155 battery charging outlets has been provided. Controlling the supply of current to this equipment is a giant switchboard in the basement having a capacity of more than 4,000 K. W.

The concrete floors and walls are poured after the tubing is in place and, after proper "setting," the tubing is with-



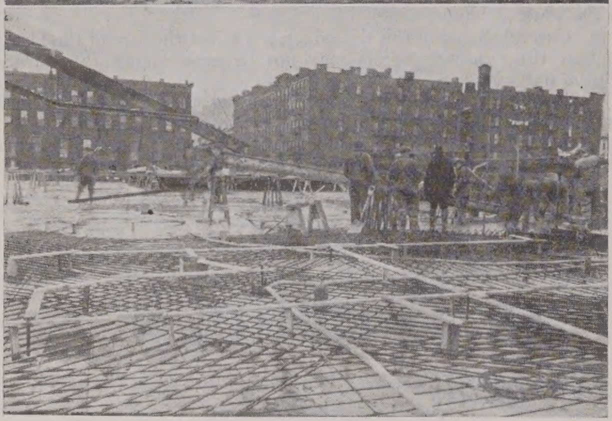


*Fig. 2—Pouring the concrete floor slab. The 2-in. gum duct connecting the distribution boxes is shown in place and at regular intervals may be seen the vertical tubes marking the outlets for lighting fixtures*

*Fig. 3—After the floor slab has set, the ⅞-in. duct connecting the ceiling outlets with the distribution boxes is laid and the concrete forming the finished floor is poured*

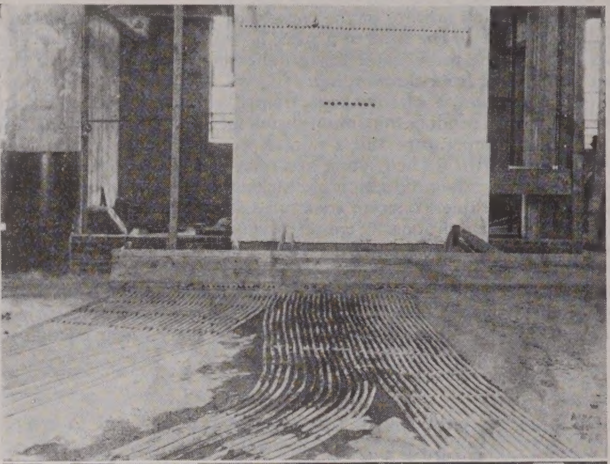
drawn, leaving a smooth, cylindrical bore running continuously between the desired points.

In the Edison Service Building the feeders were carried from the main switchboard up through ducts in the concrete walls to main distributing panels on each floor. Sub-distribution boxes were connected to these panels and the supply groups of outlets, all through ducts in the concrete floors, ceilings and walls. The boxes were formed in the shape of truncated pyramids, while in the molding of ceiling and floor outlets rubber collars 4 in. in diameter were employed.

In the installation process these boxes and duct connections to the main distributing panels were formed in the rough floor concrete and when the slab was set and the form beneath removed, there remained a finished ceiling with distribution and outlet boxes. The ducts connecting the ceiling outlets with each other and with the distribution boxes were then laid over the rough concrete, terminating in each case with a 4-in. rubber collar. The finer grade of concrete, the finished flooring, was then poured and over the surface appeared the ends of the rubber tubing, sticking up and out of the round openings dotting the floor. Next day these giant night crawlers were pulled from their holes and the duct system in that particular part of the building was ready for the electrician.

The new monolithic duct system was introduced by Thomas E. Murray in October, 1923, after years of experimenting, and offers a number of unique advantages. It simplifies greatly the mechanical problems in the placing of ducts, particularly in the cases of bends and cross-overs. The inside surface of the duct is surprisingly smooth—almost an enamel finish—with no burrs or other sharp projections to damage cable insulation. Naturally, danger of corrosion is also eliminated.

A short circuit in a non-conducting conduit, panel or pull box can be produced only by failure of the insulation in two wires of opposite polarity at the same point, a condition so unlikely to occur that this hazard may be considered as practically eradicated. And too, the system lends itself well to such projected economies as the use of bare neutral wires, there being no danger of electrolysis effects.



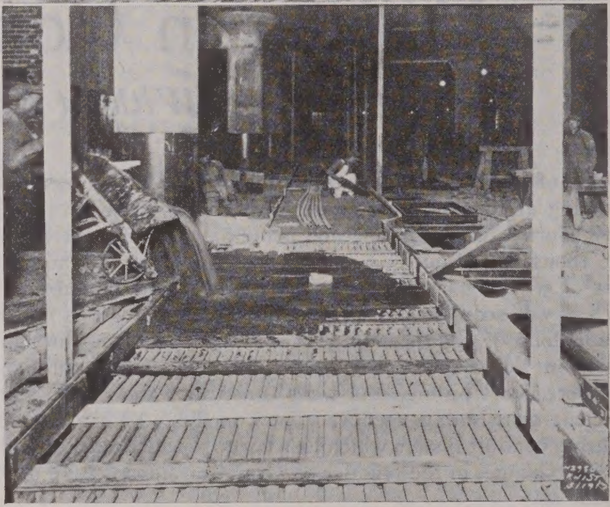


*Fig. 4—This installation shows how readily the rubber duct can be turned to change the direction of the conduit*

*Fig. 5—Close-up view showing the pouring of concrete over ducts*

The advantages of the new system, with its simplicity and low cost of installation, should lead to extensive use of monolithic wire-ways where concrete or cement is used for floors or walls. Already about a million and a half feet of duct has been constructed, half a million feet of which carries underground high-tension transmission lines of The New York Edison Co. The balance is employed in the Mount Vernon and White Plains Sub Stations of the Westchester Lighting Co., the Hell Gate Station of the United Electric Light and Power Co. and underground cable ducts in Philadelphia and Chicago.

## Crushed Brick for Concrete Block

Crushed brick for concrete has been used for many years in England. In fact it was the aggregate used by W. B. Wilkinson of Newcastle on Tyne. The patent for its use in concrete was embodied in the patent granted to him in 1854 and this was the first British patent for portland cement concrete. There is therefore in this case another instance of the expression, "There is nothing new under the sun."

# Determination of Water Imperviousness or Water Permeability of Cements

*By Evald Anderson*
Western Precipitation Co.

In order to determine how waterproof or watertight a concrete structure will be, three types of tests might be employed on the cement under consideration. First, tests may be made similar to the standard hydrostatic tests[1] for concrete sewer pipe and the water pressure increased until the specimen shows leakage. This maximum pressure will then be a measure by which the waterproof qualities of the cement may be compared. Second, the water absorption of the specimen may be determined under standard conditions, and the percentage of water absorbed, used as a measure for comparison. Third, the actual water permeability under certain standard conditions may be determined, for example, by measuring the amount of water which goes through a specimen of given thickness and area in a given time, when subjected to a definite water pressure.

The first method is not altogether satisfactory on account of its technic and because the specimens are apt to fracture under extremely high pressures.

The second method, while simple in operation, does not give a direct measure of the waterproof quality of the cement. In fact it might be doubted if there really is any direct connection between the total amount of water a concrete specimen will absorb after having been dried, and its ability to withstand water pressures without leakage. When concrete is heated until thoroughly dry, the water associated with the cement colloids and that held in the concrete capillaries will naturally be driven off. The reabsorption of the former is obviously necessary before the concrete can regain its normal state, so that the amount of water thus absorbed is only a measure of the amount of cement colloids present in the concrete. The magnitude of the reabsorption of the remainder of the water, i. e., that which was held in the concrete capillaries, might be a measure of the waterproof qualities of the specimen, but this quantity is obviously not determined when the total absorption is measured. A better measure would, perhaps, be the absorption of some liquid other than water which would not react with the cement.

The third method, like the first, gives a measure of the actual water-imperviousness of the concrete and, with its constant pressure head, it does not have the manipulative drawbacks of the first method. Essentially this third method consists in subjecting adequately aged cement mortar discs, about 3¼ in. in diameter and ½ in. thick. to a water pressure of 30 lbs. per sq. in., and determining the amount of water that is forced through in 24 or 48 hours. The amount of water thus obtained is taken as the measure of the water-permeability of the cement in question.

It is thus seen that while the first method gives a measure of the water-imperviousness of the cement, expressed in pressures, this last method measures, instead, the permeability. This is entirely analogous to determining the electrical resistance of an insulating material by measuring its conductivity, that is, by measuring the quantity of electricity which passes through the material at a given pressure or voltage, in a given time. In the case of electrical insulators, the conductivity becomes a measure of the resistance of the material while with cement the water permeability becomes a measure of the resistance to flow, or of the relative water-imperviousness of the cement.

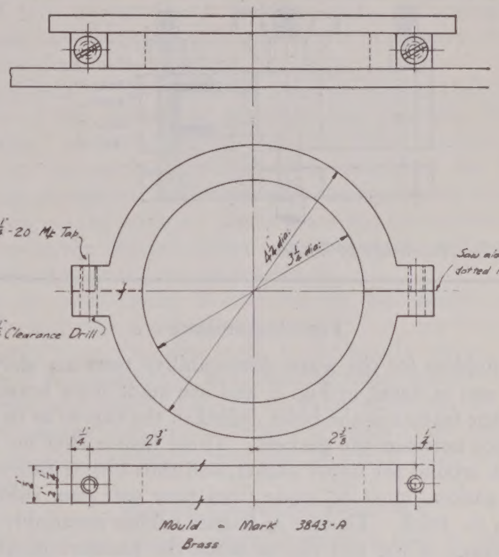


*Fig. 1—Mold for test specimen*

The exact relation between the permeability and pressure is not known. It is, therefore, necessary to keep the pressure constant, and under these conditions the permeability will be inversely proportional to the resistance or relative imperviousness, and can, therefore, serve as a satisfactory measure.

### Details of Method—Test Specimens

These are made with any desired cement and sand ratio, although a richer mixture than 1:2½ or 1:3 is of little practical use, since nearly any type of cement is fairly waterproof under these conditions. Ratios of 1 part cement to 3 parts sand, 1:4, and 1:5 should suffice. The sand used may be either the standard Ottawa sand or it may be a good uniform grade of so-called stucco sand. The latter, having a smaller proportion of voids, makes the more constant and waterproof specimen. For this reason it is important to be certain of its uniformity.

The molds used are shown in Fig. 1. The mortar should be of normal consistency, for the particular cement under test, and should be tamped into the molds, using a tamper of fairly small diameter, such as one used for the regular 2 in. x 4 in. compression cylinders.

On account of the relative thinness of the specimen it is important to use particular care in this work, since otherwise the test pieces are apt to have pinholes or blowholes.

The test pieces are kept in the moist closet for 48 hours and are then stored in water. The molds can usually be removed after 24 hours.

### Time of Storage

There are not as yet sufficient data available on the effect of the length of storage period on the water-permeability of cements. The European practice, which has been followed in these laboratories, is to store the specimen 35 days in water, and then in air for 5 days, before making the tests.

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[1] *A. S. T. M. Standards*, 1290, p. 693.

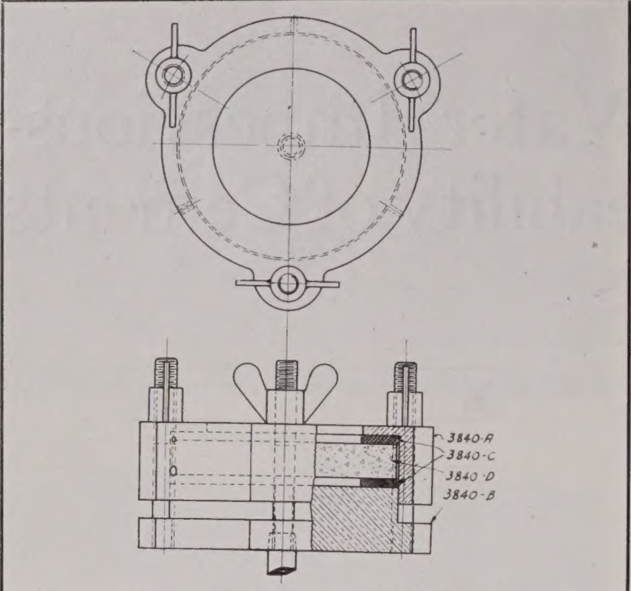

Fig. 2—Assembly of holder

TEST EQUIPMENT

The holders for the water-permeability tests are shown in Fig. 2. and in detail in Fig. 3, and are made from brass. An important feature is the holes drilled in the cap so as to drain the space between the gaskets. These insure that no water can leak around the upper gasket, and thus vitiate the results.

The gaskets must be made from pure soft gum rubber at least ¼ in. thick. Thinner or harder rubber invariably leads to breakage of the test pieces, when the pressure is applied.

The holders are placed horizontally so that the water collects on top of the specimen, in the cylindrical space formed by the gasket and cap.

Since, often the amount of water that penetrates through is exceedingly small, it is important to prevent loss of any of this water through evaporation. The cylindrical spaces above the test pieces must, therefore, be kept covered. For this purpose watch glasses may be used to advantage.

Where uniform water pressure of the right magnitude is not available, a pressure regulator can easily be improvised from a few pieces of pipe and fittings and some mercury. An outline of one is shown in Fig. 4. With a mercury head of about 5 ft., 30 lbs. pressure can be maintained. The water supply pressure must necessarily be at least 30 lbs. The value from this supply is kept open just enough to insure a slight but constant overflow through the mercury column. Fig. 5 shows an assembly of a bank of 4 holders, with a pressure regulator.

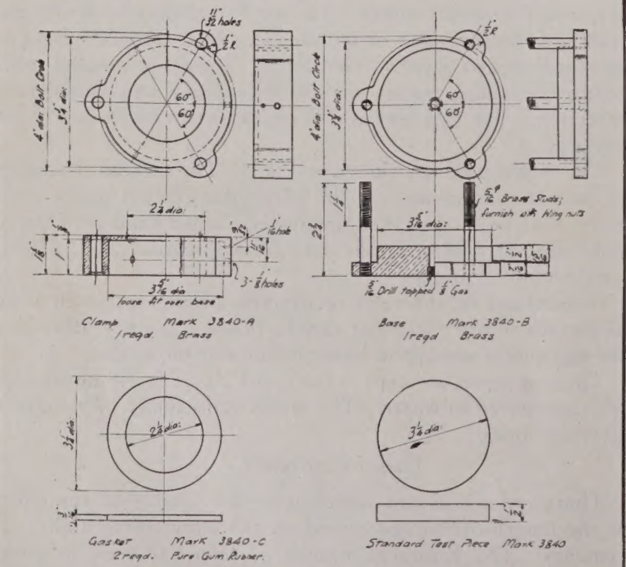

Fig. 3—Detail of holder

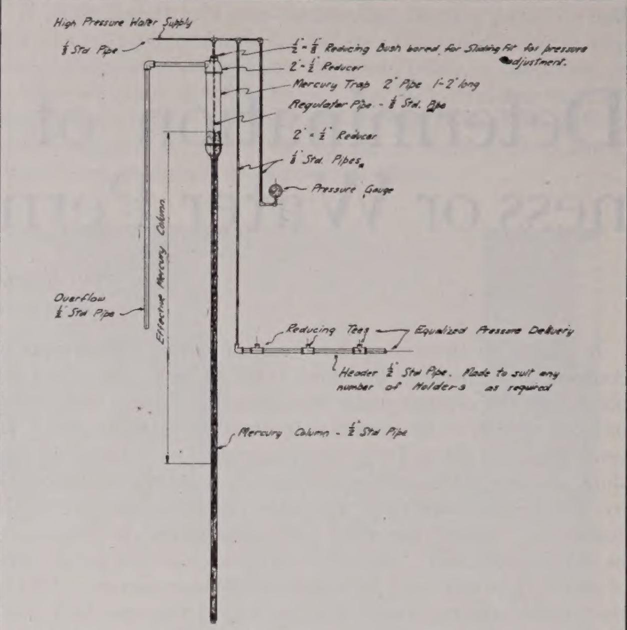
High Pressure Water Supply
1/8" Std Pipe
1/2"-1/8" Reducing Bush bored for Sliding Fit for pressure adjustment.
2"-1/2" Reducer
Mercury Trap 2" Pipe 1'-2" long
Regulator Pipe - 1/8" Std. Pipe
2"-1/2" Reducer
1/8" Std. Pipes
Pressure Gauge
Overflow
1/2" Std Pipe
Effective Mercury Column
Reducing Tees
Equalized Pressure Delivery
Header 1/2" Std Pipe. Made to suit any number of Holders as required
Mercury Column - 1/2" Std Pipe

Fig. 4—Pressure regulator

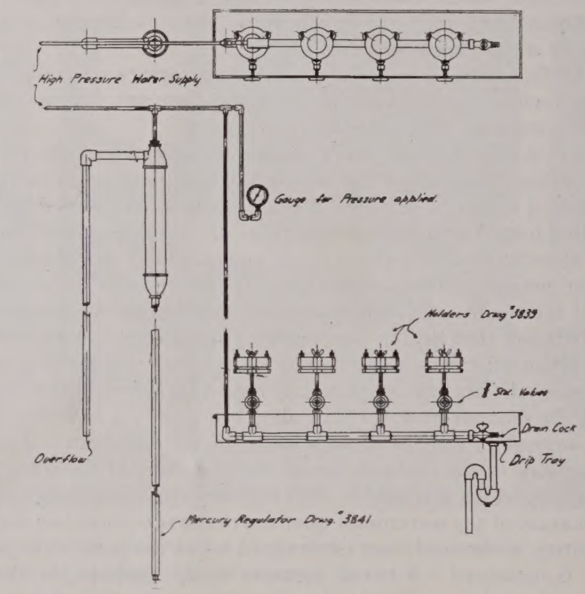
High Pressure Water Supply
Gauge for Pressure applied
Holders Drwg. 3839
1/4" Std. Valves
Drain Cock
Drip Tray
Overflow
Mercury Regulator Drwg. 3841

Fig. 5—Assembly of test equipment

WATER PRESSURE

The water pressure should be sufficient to cause a measurable amount of water to go through in a reasonable time, without danger of breaking the specimen. The experience in these laboratories indicates that 30 lbs. to the sq. in. is fairly satisfactory, although with this pressure and test specimen made with rich mixtures, occasionally only a trace of water goes through. Thirty pounds has, however, been provisionally adopted as the standard.

MANIPULATION

The making of the tests is exceedingly simple, and consists only in taking up and weighing the water which is found on top of the test pieces. Where only a small amount of water goes through, this is best taken up by means of weighed filter papers. These filter papers are first weighed in weighing bottles. Then the water on top of the test piece is carefully blotted up with one or more papers and these papers then again placed in the weighing bottle, and the increase in weight determined. When larger amounts of water go through, the greater portion may be drawn off and measured by means of a small pipette.

The duration of the tests may be any convenient period, but should not be less than 24 hrs.

### CALCULATION OF THE RESULTS

The amount of water which goes through the specimen is naturally determined as grams, so that the most obvious method of expressing the results would be as grams per day per square centimeter at a given pressure. For ordinary use it is perhaps better to recalculate this into pounds, or fluid ounces per square foot per year. With the size of holder shown in this paper, the diameter of the free area of the test pieces, i. e., the inside diameter of the rubber gasket in the holder, is 2 in. Naturally, the actual diameter of the part of the specimen through which the water passes is somewhat greater, but since the results are chiefly comparative, this can be neglected. On the basis of an effective diameter of 2 in., the water permeability in pounds per square foot is obtained with sufficient exactness by multiplying the weight of water in grams which passed through the specimen, by 0.1.

### NUMBER OF TEST PIECES

On account of the difficulty in making uniform and satisfactory test pieces, free from pinholes, it is necessary to make tests on a relatively large number. The European practice has been to make from one to several dozen, but in this laboratory satisfactory results have been obtained on from six to twelve pieces. This number is, however, the absolute minimum that should be tested.

### TYPICAL RESULTS

The following tables show some results obtained with the method.

Table I gives the separate figures for one set of six test pieces, these figures being the weight of water, in grams, which passed through the individual test pieces in the first and second 24 hours. In calculating the average from these figures, number 4 would ordinarily be omitted.

Table II gives the comparison between the water permeability of two different types of "waterproof" cements, with different cement to sand ratios, and Table III shows the comparison for the 1:5 ratio of cement and sand of two "waterproof" cements and one ordinary cement.

TABLE I

Weight of water passing through cement test pieces, one-half inch thick, and with an effective area of 3.14 sq. in. at 30 lbs. pressure.

| | *Weight of Water* | |
|---|---|---|
| *Number of specimen* | *First 24 hours* | *Second 24 hours* |
| 1 | .0194 Gm. | .0234 Gm. |
| 2 | .0349 | .0271 |
| 3 | .0490 | .0842 |
| 4 | .8655 | .8740 |
| 5 | .0255 | .0298 |
| 6 | .0830 | .0590 |

TABLE II

Water permeability of "waterproof" cements at 30 lbs. pressure—expressed as fluid ounces per square foot per year. Thickness of specimen, ½ in. Ungraded sand used.

| | *Permeability* | |
|---|---|---|
| *Proportion of sand* | *Cement No. 1* | *Cement No. 2* |
| 1 part cement, 3 parts sand | Trace | 47 |
| 1 part cement, 4 parts sand | 14.5 | 405 |
| 1 part cement, 5 parts sand | 22.7 | 873 |

TABLE III

Water permeability of 1:5 cement-sand mixtures of "waterproof" and ordinary cement—expressed in fluid ounces per sq. ft. per year. Thickness of specimen, ½ in. Ungraded sand used. Pressure 30 lbs. per sq. in.

| *Type of cement* | *Permeability* |
|---|---|
| "Waterproof" No. 1 | 23 |
| "Waterproof" No. 2 | 873 |
| Regular cement | 2900 |

# Factors in Cement Setting

From a paper read at the International Cement Congress by the late H. K. G. Bamber, London, England.

In the course of the author's somewhat lengthy experience in the cement industry he has found that the factor in the use of cement least understood, and productive of the most difficulty and sometimes disappointment to the structural engineer and general user, is the property which cement possesses—in combination with water—of consolidating itself into a permanent rocklike mass, enlocking in the process any materials with which it is in contact and which are not chemically repellent.

It should be obvious to all users of cement that the time limits of this process of consolidation, generally known as "setting," must be outside the time limit required for the sum of the mechanical operations employed for properly mixing the cement and water with the aggregates to be used, and placing the resultant plastic mass into its required station, otherwise the crystallization constituting the setting will be interfered with or perhaps destroyed.

In the preparation of concrete the fact should never be overlooked that the binding material—i. e., portland cement—before use, in its dry state, is chemically active and in a state of unequalibrium until the requisite quantity of water is added and absorbed to encourage the chemical changes and combinations with establishment of equilibrium resulting in setting, the progressive processes of which must not be disturbed.

### WATER ABSORBING PROPERTY

Much of the trouble which arises from time to time in the hands of some consumers in connection with the use of this material is the result of the failure to appreciate that Portland cement, although in itself a completely manufactured material is really in its dry condition, as sold, an unstable chemical compound always seeking to satisfy itself by absorption of water, which it proceeds to do with the greatest avidity as and when opportunity accidentally or intentionally is afforded. Unless cement possessed this property it could not fulfil the purpose of its creation, and, therefore, its power to act in such manner must not be judged to its detriment.

The author has known a case where an aggregate which appeared under ordinary examination to be suitable in all respects, turned out to be useless with one high-grade portland cement, and satisfactory with another, both being well-known brands of the highest quality, testing far in excess of the British Standard Specification requirements. Chemical and physical examination failed to detect the disturbing element which, while permitting one cement to set satisfactorily, absolutely destroyed the setting properties of the other, a change of aggregate resulting in both cements being satisfactory.

### SLOW SETTING CEMENT

At all times the best results are likely to be obtained by the use of slow setting cement. It is a fallacy to suppose that greater strength is obtained at early dates by the use of moderately quick setting cements, which are always more liable to be injured if the work is not carried out with the greatest expedition.

The greatest safeguard which the engineer possesses is to obtain slow setting cement from absolutely reliable sources, and when it comes into his possession or under his supervision to protect it with all reasonable care against atmospheric influences, regulating his constructional operations so that the time taken for their complete performance is not extended beyond the time when the cement commences to set, which may vary from day to day, depending upon the temperature and hygroscopic condition of the atmosphere.

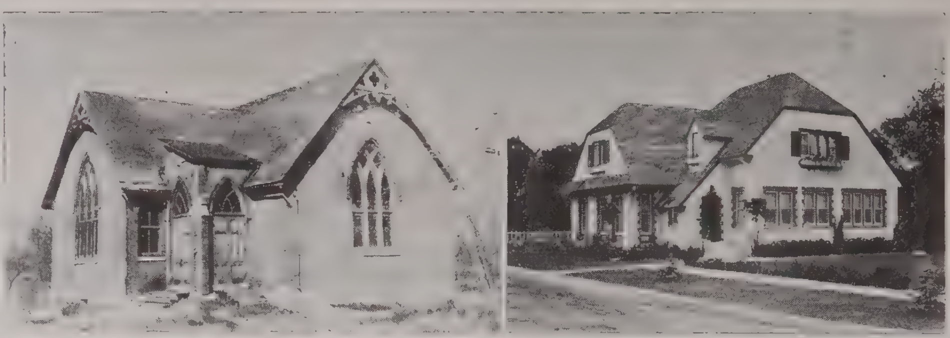

*Fig. 1—Here you see an old church remodeled to make a very attractive home for A. Leytze; Hanson and Oltfillesch, architects and engineers; A. R. Coffeer, contractor*

# Remodeling and Overcoating with Portland Cement Stucco

*By Samuel Warren*
Manager of Atlas-White Dept.
The Atlas Portland Cement Co.

Stucco is far from being a material to be used only on new construction. It is a material almost unique in its possibilities for rejuvenating and remodeling old buildings and bringing their values up to present day standards.

Scattered throughout the country are endless buildings that have seemingly passed their prime. The exteriors are of an architecture of a by-gone period or have become dilapidated. Repairs and changes have been made which show up badly and give a lack of uniformity to the exterior surface. Usually such buildings were erected during a time when the best of materials and workmanship were used and are fundamentally sound and capable of many years of usage but because of their appearance it is impossible for the owner to secure a good revenue from their rental.

In other cases the growth of the city has been such that certain sections are passing from residential to business uses or from private residences to apartment houses. This necessitates major changes in the buildings, very often consisting of removal of high stoops and making an English basement entrance or the lower floor may be made into a store. This calls for structural changes in the exterior that make it very difficult to match the old work with the new and here again the coating of stucco covers the patching.

In residence work particularly the results are very remarkable. Many of these old houses are quite hopeless from the exterior in that they were covered with meaningless ornamentation which is very expensive to be kept painted. Moldings and details were what are now considered of impossible design, yet the interiors are often very attractive with large spacious rooms that can be easily modernized with proper wallpaper and the painting of the woodwork. Many of these old homes have long associations and the owners hate to give them up. However, the work of rejevenating with stucco is most satisfactory.

At first glance it would seem to be a very large expense to overcoat one of these old houses, but it is surprising how simple the matter is. Of course, in many cases, the owner will wish to more or less remodel the house and make structural changes. There may be an awkward tower so popular about 1880 that he will wish to remove, or the ends of the roof peaks may have been chamfered off, or there may be a baywindow which displeases the owner. These details can

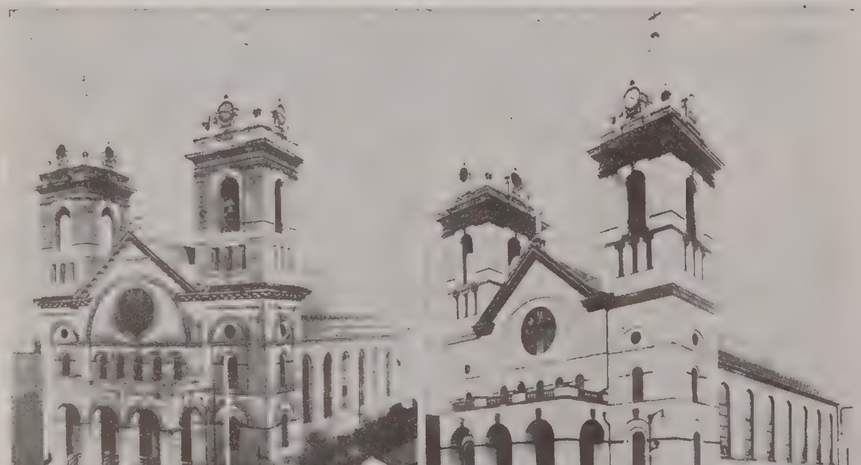

*Fig. 2 shows St. Teresa's Roman Catholic Church, Brooklyn; Robert J. Reilly architect; Fordham-Stone Renovating Co., contractor* usually be handled quite simply, as it is not necessary to go to much pains in patching the siding. The work is just substantially done and then any signs of the patching disappear under the stucco. The other points to watch are where the stucco meets the window and door openings. If the molding is fairly heavy there is usually enough to take care of the extra thickness of stucco which will run about 1½ in. If not, an extra piece of molding can be attached to the window or door frames or the molding can be removed to the line of the old wood facing and the stucco returned to the frame.

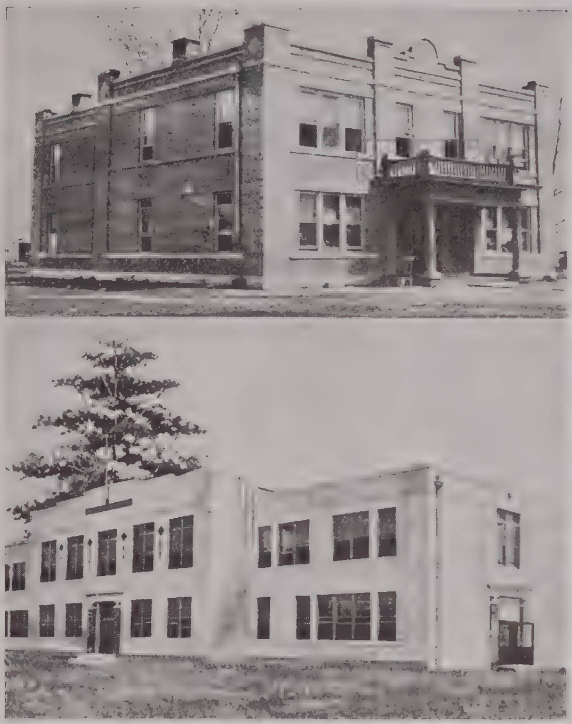

*Fig. 3—Brick School, Ruleville, Miss., built in 1908 enlarged, remodeled and overcoated with Atlas White cement stucco, 1922*

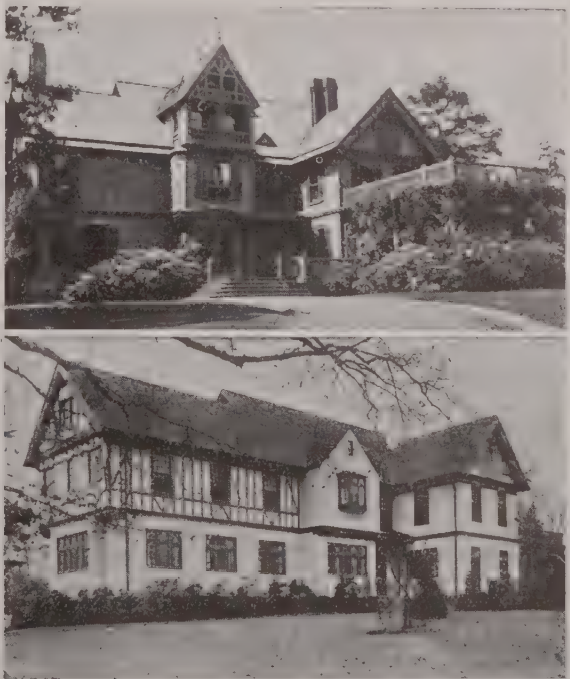

*Fig. 4—The Otto Meyer residence, Montclair, N. J., before and after remodeling and stucco overcoating under the direction of Lucian E. Smith*

It is rarely necessary to remove the old outside covering, whether it be shingles, clapboards or siding unless they are very rotten and in very bad shape. It is usually sufficient to go over the house and see that any loose outside covering is nailed on tightly, then the entire exterior is covered with waterproof building paper, over which is applied the furring strips and then the metal lath. The stucco is then applied as would be in any new work of this nature.

Care should be taken when stuccoing over old water-tables or any projections of this nature to see that the lath is kept away the full depth of the furring strip so as to make certain of the thorough embedding of the lath in the stucco. There is a great tendency in the case of these portions of a building to tack the lath directly over the old wood and this eventually leads to trouble.

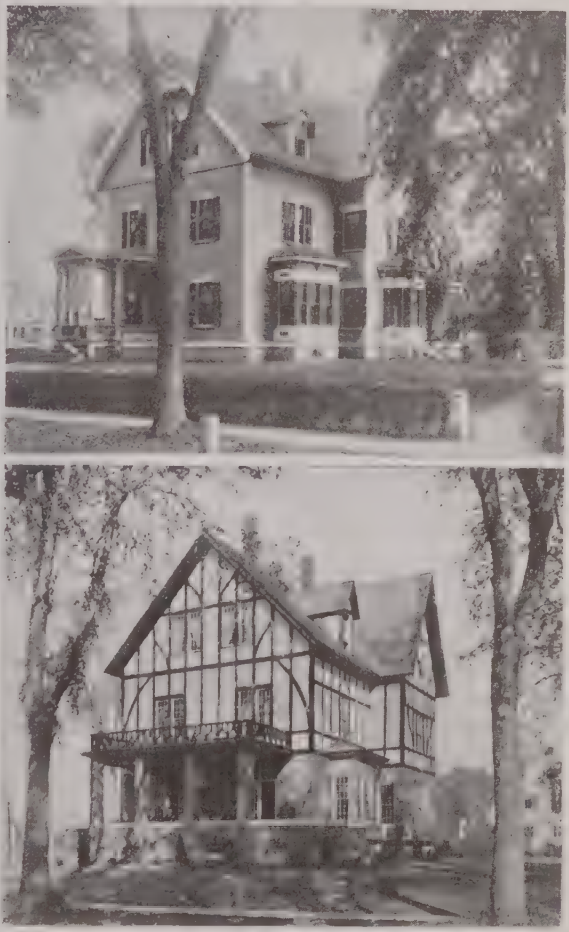

*Fig. 5—Sigma Phi Epsilon House, Dartmouth College, Hanover, N. H., "done over;" Larson and Wells, architects, Hanover; W. H. Trumbell, contractor, Hanover*

In the case of old brick buildings, the treatment will depend upon the condition of the wall. If the wall is of common brick and rather porous and has never been painted, it can usually be prepared for stuccoing by giving it a thorough cleaning with water and a brush. Often, however, the brick has been painted, or has stood so long that the pores of the brick are entirely filled with dirt, and either of these will prevent the bonding of the stucco. It is necessary to give the stucco a clean new surface on which to bond. This is done by hacking the surface, either with a bull point or a chisel or a sharp pointed stone hammer. This hacking means an entirely new surface and does not mean just occasional hack marks making two or three to a brick. No one would consider partially painting a brick wall or a hollow clay tile

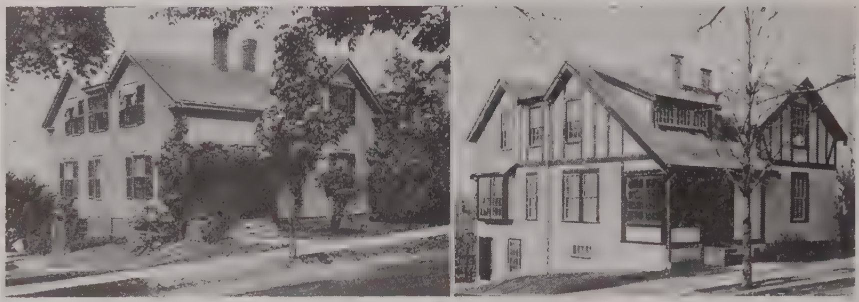

*Fig. 6—Professor Phelan's house before and after remodeling, Medford, Mass.*

*Fig. 7—Building at 1309 Locust Street, Philadelphia, before and after. Duhring-Ziegler, architects, Philadelphia; Krafft Murphy Co., Washington, D. C. This job has three coats of stucco on metal lath attached to original brick work, the final coat with a coarser aggregate, color buff*

wall before stuccoing, yet very often people will try to stucco over an old painted brick wall with probably hardly 10% of new brick surface exposed. The results are not fair to the stucco.

Particular attention is called to the photographs below which show the proper and improper methods used in preparing brick for stucco. The first case is of an old painted wall where a few chisel marks were made and over which the stucco was applied. Fortunately in this case the building was set back from the street so when the stucco fell off nobody was killed. The other picture shows a clean, freshly fractured surface which will give an ideal bond for the stucco.

Old stucco work is prepared in the same way. That is the surface is hacked until a new surface is exposed. This applies to the softer and more absorbent stones.

In case of hard burned face brick or a dense impervious stone such as granite, it is best to cover the work with metal lath as there is not apt to be sufficient absorption in either this type of brick or the stone to make the stucco bond properly.

Naturally, much of the value of this work is obtained in securing attractive color and texture in the finish work, and for this purpose the white portland cement is strongly recommended.

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The U. S. Bureau of Standards has issued circular 205 containing United States Government master specifications for gypsum plaster as officially promulgated by the Federal Specifications Board November 5, 1924.

## Color Roof Tile All the Way Through

At least one manufacturer of concrete roof tile is solving his color problems by using a cheap colored aggregate all through the body of the tile.

L. Hansen, L. Hansen Co., Kansas City, producing roof tile machines as well as tile has announced a process which he does not describe in detail to obtain positive color permanence.

Inquiry of Mr. Hansen brought the following information:

> Hansen tiles are colored all the way through. The ordinary old method of coloring tile roofing by sifting on the top a mixture of portland cement and coloring pigments is pure humbug, not because —as suggested—the troweling action separates the color from the cement and aggregate and brings it to the top where it washes off under rain and snow. Our old method of making tile did not separate the coloring pigments from the cement and aggregate because very little or no troweling has been done. But the coloring finish coat on the tile has disappeared, (not faded) and left the tile showing only the aggregate with its own color, as it is impossible to color sand, etc., artificially. For making permanent colored tile—the writer has found —an aggregate or binder having in it itself the color wanted must be used, so that it is not left to a weak finish coat of cement, etc., but to a solid body of concrete—colored through—to resists the attack of the elements.
>
> By a good many years of practical experimenting, tryouts and tests the writer has found a way to make an ideal concrete tile roofing of excellent durability, quality and beauty which can be manufactured and sold on a sound commercial basis leaving a liberal profit to the manufacturer.

Mr. Hansen says his aggregate which makes his tile resemble terra cotta tile very closely, is cheap and its use in every way practicable.

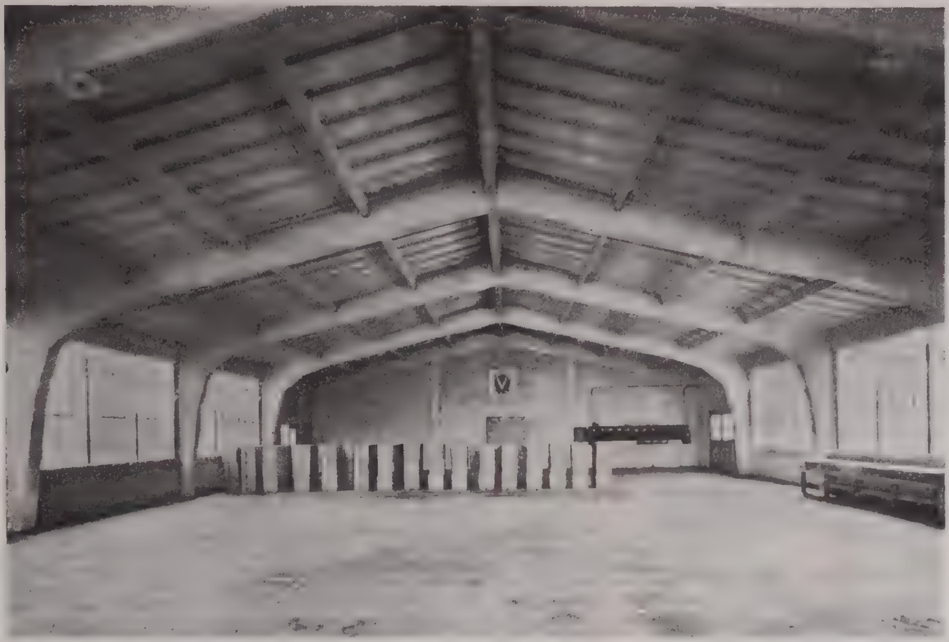


*Fig. 1—Meter plant with clear span of 60 ft. at Emeryville, California, built by Villadsen Bros., Inc.*

# Rigid Concrete Frames for Long Spans

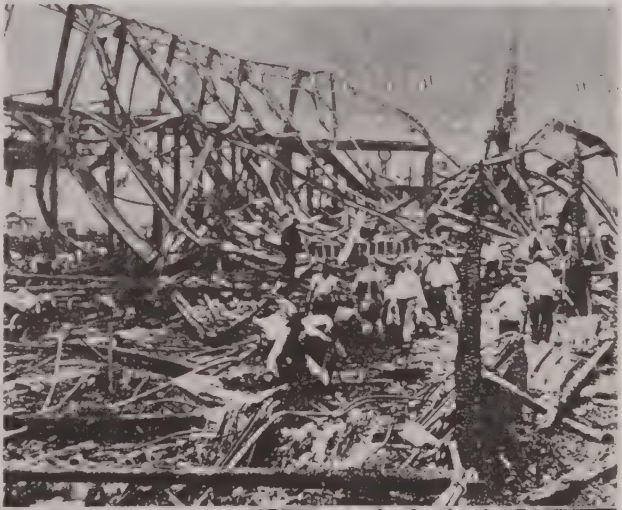
The accompanying illustrations of a plant just completed at Emeryville, Calif., by Villadsen Bros., Inc., San Francisco, Calif., show some of the advantages of rigid frame concrete construction. This building which is one of a number of the same type which have been built by Villadsen Bros. is a meter building, 60 ft. x 120 ft. in plan. The roof is supported on rigid concrete frames spanning the 60-ft. dimension and spaced about 17 ft. on centers. This type of building was selected because it is light and more fireproof than any other type with long span.

The owner was convinced that this type was worth more in a fire than a steel truss building when he was shown the pictures in figures 2 and 3, one of which shows the remains of a steel building, which had gone through a fire. The owner's attention was directed to the total wreck of the steel building and the fact that the steel trusses not only crumpled but also pulled down the walls. It was evident to him that it would take a long time to clear up the wreck, not to mention rebuilding the structure. While on the other hand, if fire should get to one of the buildings with concrete frame and wooden roof, a panel or two might burn out, but the concrete trusses and walls would stand, and the roof could be repaired in a couple of days. He would probably be ready for business again within a week after the most severe fire.

Fig. 5 shows the interior of the building with the line shaft attached to the concrete beams, $\frac{7}{8}$-in. bolt inserts being placed every 6 ft. at the soffits of the frames.

Among the advantages pointed out by the builders with regard ro rigid concrete construction are the following:

In the first place, where large spaces are required without columns, this type is the most economical type of structure and compared with structural steel, the concrete has proved itself reliable in fire. It requires no paint and maintenance cost and has no large number of members to collect dust and obstruct light. These rigid frame concrete structures are the latest developments in structural engineering. Innumerable long spans have been built in Europe during the last 25 years and are considered standard practice there. With the methods



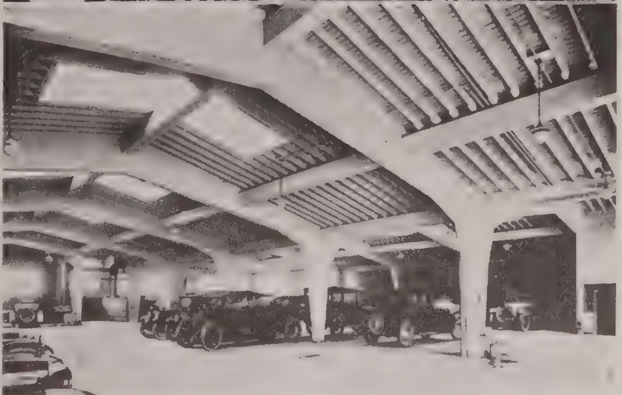


*Fig. 2 (Upper)—Wreck of steel frame building destroyed by fire. View used to convince an owner of the worth of a reinforced concrete building*

*Fig. 3 (Lower)—Garage building, Salt Lake City, 50-ft. span*

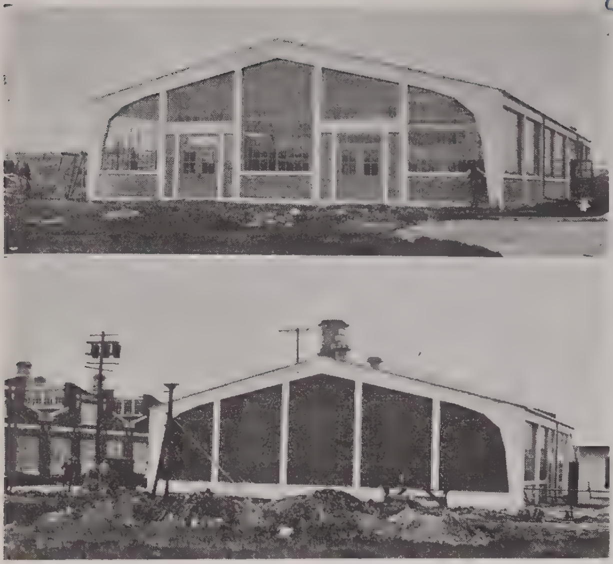


*Fig. 4—Exterior views of meter plant shown in Fig. 1*

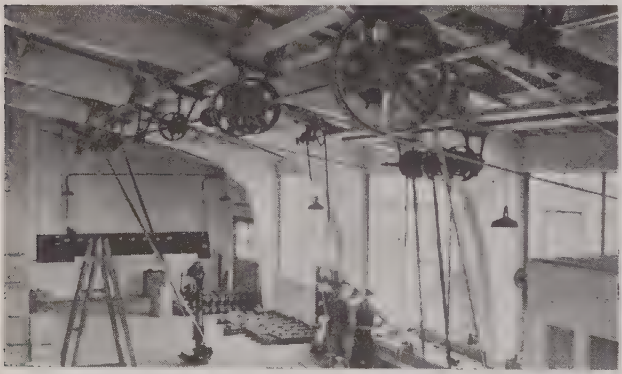


*Fig. 5—Interior view of meter plant showing machinery fastened to concrete*

of form unit construction employed by the builders, the resulting prices are about the same as for non-fireproof steel buildings.

One important long span concrete structure of recent date is the Palace of Industry covering 300,000 sq. ft. of ground in the British Empire Exposition at Wembley. Villadsen Bros. are making good progress in introducing this type of building in California and are confident that in the future, long span rigid concrete frames will replace the steel trusses generally as they are doing in Europe.

## For Better Plastering

The Associated Metal Lath Manufacturers, Chicago, Ill., sponsors a movement to cause home owners to realize the importance of those parts of a building which are not *seen* but which determine the amount of repairing that will be required and the ability of the structure to resist fire. This educational campaign under the style, the National Council for Better Plastering is designed to awaken an appreciation of plastering as the most important contract in building a home and to acquaint people with the fact that the plastering base, itself unseen, determines the satisfaction the plastered surfaces will give.

To the lather and the plasterer this Better Plastering movement brings a welcome feeling that his work will be brought to the attention of the owner in a more favorable light, with a clearer understanding, and that the present low quality tendency in interior finish will be discouraged.

# Alumina Cement in Factory Construction

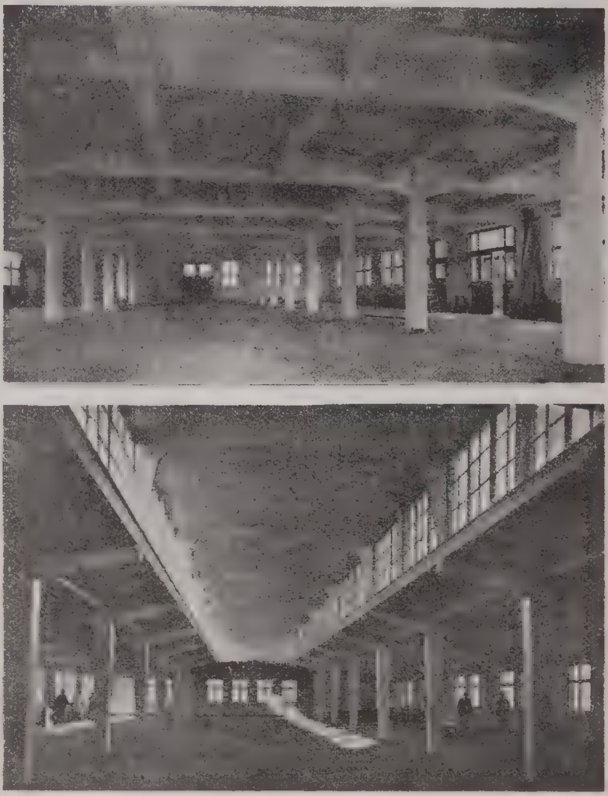
*By E. Lee Heidenreich*

Abstracted from *Beton u Eisen* by E. Lee Heidenreich.

A wood construction factory of Siemens & Kalske in Charlottenburg had to be replaced by a fire proof construction.

The vibrations caused by the machinery and the necessary minimum dimensions of construction, as well as a satisfactory exterior caused the selection of a concrete construction, which, owing to the short time available, was built of concrete made from the now modern alumina cement,—Mark "Rittergut Rudersdorf," in a mixture of one cement, two sand, and three crushed stone.

Trial cubes of 6-in. size, gave after seven days, an average compressive strength of 5250 lbs. per sq. in., and in 28 days, a strength of 6600 lbs. per sq. in.



*Figs. 1 and 2—Interior views of factory constructed of alumina cement concrete*

In consideration of these experiments, all forms were removed after the sixth day, and the entire time of building from the first pouring of concrete of the foundation, to the removal of all forms in the last story, amounted to 38 days.

Fig. 1 and 2 give views of this building.

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The old fashioned method of mixing concrete without paying attention to the amount of mixing water is giving way to definite and scientific methods wherein the water which goes into the mix is gauged by the slump test. Where no means is provided for regulating the water and the amount is left to be governed by the foreman on the job, a good rule to follow is that the least water used the better the concrete, so long as the mix can be handled properly and placed around the reinforcing steel.

# Concrete Pipe for Foundation Piling

The use of concrete culvert pipe in the construction of the foundation piles for a store building is one of the unique features in the construction of a store building built by G. E. Krause at Juneau, Alaska on a lot where each rising tide covered half or all of the building site. The accompanying foundation plans show the irregular shape of the lot. The owner decided to build a store on the lot and desired a basement if possible.

A few months before the present owner purchased the site, a former building supported on wooden piling had burned down. The old wooden piles were cut off flush with the bottom of the concrete basement floor of the new building and utilized in the construction of the new structure.

The fact that every high tide covers at least half of the lot made it necessary that all piling and basement work be done between tides. It was also necessary to contend with considerable seepage from the street at the front of the lot. The builder who was instructed to design and construct the concrete building decided upon the use of culvert pipe for piling. The pipe used were the same as the building had manufactured for the United States Bureau of Public Roads for the past two years for use in culvert work. Every pipe was reinforced with A. S. & W. 4-in. triangle mesh wire and complied with government specifications for culverts. Raber & Lang bell end culvert molds were used in making the pipe.

Although it was originally planned to use three 4-ft. lengths of pipe to each foundation pile, with some of the pipe 24 in. in diameter as seen in the accompanying illustration, the plans were changed and three 4-ft. sections, 18 in. in diameter and one 4-ft. section 12 in. in diameter were used in each pile except those in the back row where four sections 4 ft. long and 18 in. in diameter were used in order to make the back row extra heavy to withstand the action of bumping logs, etc. floating with the tide. The pipe used were well cured, each pile being rested on a footing 2 ft. thick and 3 ft. square. At the time the footings were poured, four ¾-in. rods were placed to extend up through each .pile. Reinforcing for the outside pile extended through the girders and up to the top of the building. The reinforcing rods for the inside piles extended up through the pillars to the joists.

The only concrete piling for the basement consists of four pillars, made by butting two 12-in. pipe together, reinforced the same as the other piles. After all reinforcing was placed, concrete was poured in the inside of the pipe, the joints of which were all cemented when they were set.

The entire basement wall was 12 in. thick with 4-in. extensions which formed pillars. The footings for the basement wall averaged 4 ft. deep and 20 in. thick being reinforced with regular railroad rails. All reinforcing was placed continuous and fastened according to best practice.

The store part of the building is of double wall construction with 2-in. air space of concrete blocks made on a Helm machine. About 7000 16-in. block were required. The supporting girders were 12 in. x 24 in. of reinforced concrete. Before laying the first block course, a layer of tar paper was placed on the concrete girders and the wall to prevent the passage of moisture from the girder and wall and the inside of the building was plastered directly on the blocks.

The front of the store consists of four pillars of reinforced concrete with rough stuccoed panels. The stucco was made of one part cement, one part hydrated lime, two parts ¼-in. to ½-in. pebbles. The upper part of the front is of dark red concrete brick, colored with Helmuth red rooftile coloring, using four and one half pounds to one sack of cement. The front has been completed several months and although the weather has been rainy and high winds blowing the salt water in during freezing temperatures for over a month, the red brick withstood the action of the elements and appear the same as when they were laid. The corners are laid with 4-in. and 12-in. rough face cement color block, and the top trim is 4-in. cement color block and cement color brick.

After the basement wall forms were removed, the outside of the wall was brush coated with a putty of 2 parts cement and 1 part of hydrated lime. The piling was also brush coated With the same putty. The inside of the basement wall was coated with cement and hydrated lime using the same proportions as for the topping of the concrete basement floor. The first course of the basement floor was 5½ in. thick reinforced with 049 A. S. & W. 4-in. triangular mesh fastened to the wall reinforcing. A Norwegian portland cement was used

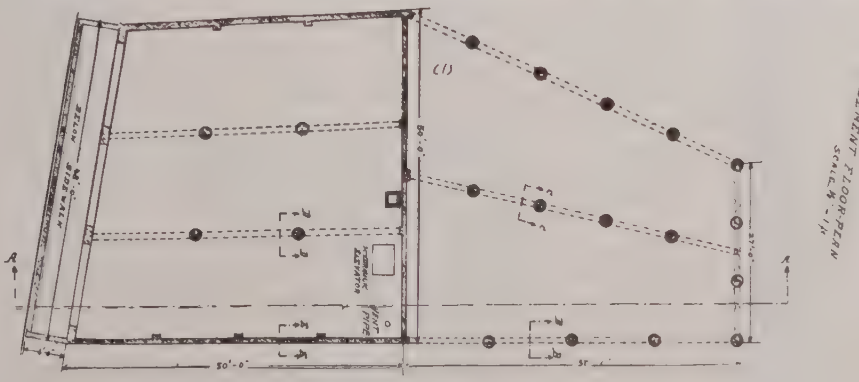


*Fig. 1 — Basement floor plan showing irregular shape of building site*

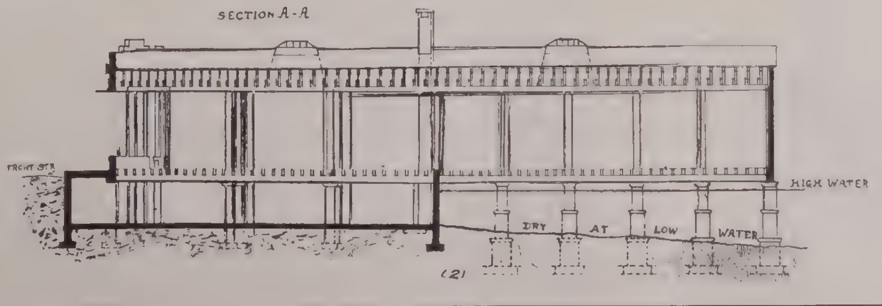


*Fig. 2—Section A-A through longest portion of building*

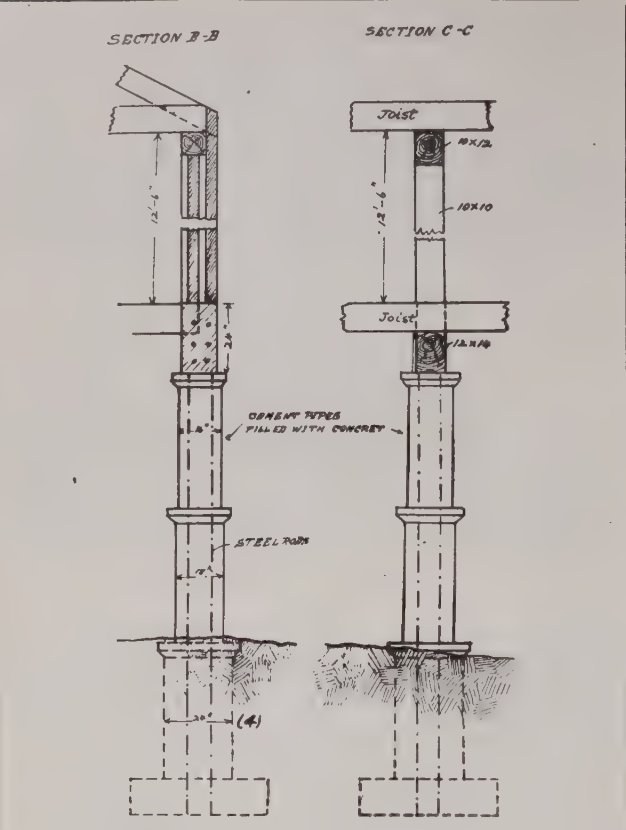


Fig. 3—Sections B-B and C-C showing arrangement of pipe piles

and to every sack of cement 10 lbs. of hydrated lime was added. No other waterproofing was used but all concrete was well tamped. All concrete was hand mixed and thoroughly tamped.

At the lower corner of the basement a 6-in. vent pipe was placed to take care of tidewater pressure from the floor. When the tide comes in, air is blown through the pipe like steam from a boiler blow-off. Near this vent pipe was installed a hydraulic elevator. The shaft was sunk 10 ft. below the top of the basement floor. Considerable difficulty was encountered in sinking the elevator shaft and the vent pipe was found to aid materially in making the opening around the shaft watertight by relieving so much pressure.

The store building is used for grocery and meat markets, the market occupying about one third. It includes a modern cold storage plant, constructed of concrete block, the same as those used in the walls of the building, lined with two layers of 2-in. cork, the cork being coated with one coat of portland cement and on top of this, one coat of Medusa white cement. The outside of the cold storage, on the side and back is plastered like the rest of the store and the other side is built on the wall.

The reinforcing rods consist of vertical ¾-in. rods with ¼-in. cross rods spaced one foot apart. The foundation and walls were designed to permit the addition of another story in case the owner decides to build apartments above.

According to Mr. G. E. Krause, the builder, to whom CONCRETE is indebted for this information, the well cured culvert pipe proved very satisfactory and were easy to handle and place, eliminating the worry ordinarily due to curing the concrete in salt water. A 20-ft. tide, the highest experienced at that place in 3 years placed the basement entirely under water for almost 7 hours and no seepage resulted in spite of the great amount of pressure.

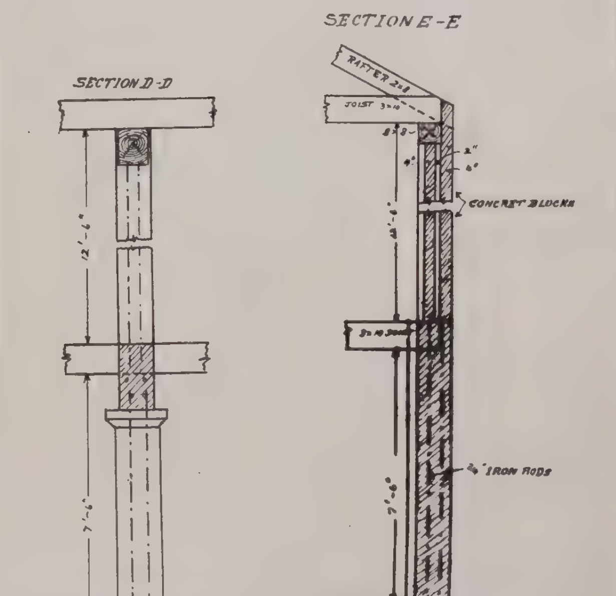


Fig. 4—Sections D-D and E-E through basement portion

## Concrete Masonry Units

Very few realize perhaps the spectacular growth in manufacturing concrete masonry units. An inquiry from a reader of CONCRETE for statistics and for some statement of the effect of the concrete building unit industry on the clay products output, was referred to the Portland Cement Association, and from the reply the following was prepared:

Portland Cement Association estimates on the output of concrete block and building tile combined (in terms of standard 8 x 8 x 16 block) is as follows for the period 1920-1924:

| | |
|---|---|
| 1920 | 50,000,000 |
| 1921 | 175,000,000 |
| 1922 | 297,000,000 |
| 1923 | 385,000,000 |
| 1924 | 462,000,000 |
| For five year period | 1,369,000,000 |

The association made no estimate on concrete brick as the gain probably was not large and the 1923 estimate reaching 190,000,000 is probably about right.

Latest reliable estimates placed common clay brick output at about 6,000,000,000 or equal to 461,500,000 standard concrete block, just about equal to the estimated output for 1924.

If total volume of building remains as great in 1925 as in 1924, distributed among various classes of structures about as at present, concrete building products will get a greater proportion and the output should increase from 10% to 20%.

Some years ago the estimated production of clay common brick was nine billion. Latest estimates run around six billion. In the meantime volume of building has increased. The difference is represented almost entirely by reinforced concrete and concrete masonry and perhaps slightly by clay tile competition. The use of clay face brick has increased, and deservedly, through the introduction of many new and attractive textures and colors. The clay hollow tile output figures apparently are not available. Concrete partition tile, particularly those made with cinder aggregates, are beginning to affect seriously the clay tile business in half a dozen of the larger centers.

# Concrete Road Built with Combination Haul Plant

Hill and Hill, Elyria, Ohio, had a contract at the beginning of 1924 from the State of Ohio for the construction of 15 miles of concrete road, designated as the Niles-Ashtabula Road; 16 ft. wide, 7 in. thick, with 2-ft. edges thickened to 9 in. The mix was of 1:1½:3.

About 3 miles of the road was old macadam in very bad condition. The rest was of clay with some gravel mixed into it. The whole road after the winter season was in very bad shape, and the possibilities of hauling over it at the beginning of the season were nil. The railroad paralleled the road about 4 miles away. After careful consideration of all types of hauling, and the impossibility of truck haulage at the beginning of the season and the delays that were sure to come with every fall of rain if trucks were used to haul over the subgrade, the contractors decided to use a combination of trucks and narrow gauge railway.

The general plan was as follows: The proportioning yard was set up at East Orwell. From here a road led straight to the road to be constructed, 4½ miles distant. The beginning of the work was 2½ miles south of this intersecting point. This 2 miles and the 2 miles north of this point were built from narrow gauge track. The trucks with trailers attached hauled properly proportioned batches in batch boxes to the railway. These batches were then transferred from trucks to narrow gauge cars and hauled to the mixer.

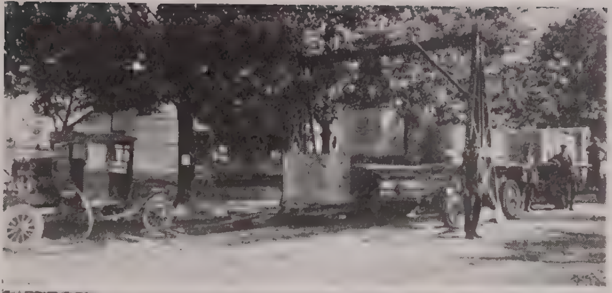
When the 2 miles north of the intersecting point were completed, a portion of the pavement was cured enough to allow the trucks to haul over it. The narrow gauge track along this portion was moved up ahead and the transfer plant also moved. Thereafter each day the track and transfer point were moved until 3½ miles of road were built north from the intersecting point of the road under construction with the road from East Orwell.

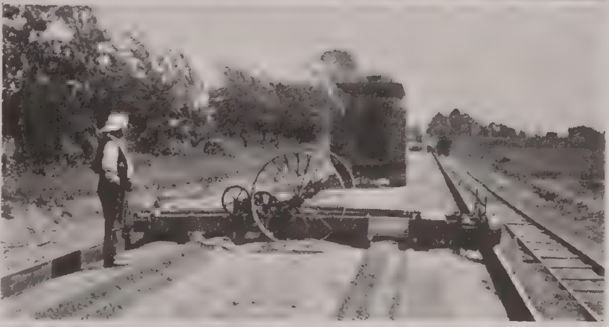
Then the proportioning yard was shifted to Rome. The road from Rome was 3½ miles from its point of intersection with road under construction. The 2 miles to be built from this point to the end of the piece built from East Orwell was constructed from industrial track. The 4 miles north of point of intersection of the road from Rome with the road to be constructed, were constructed as described above, the track and transfer point being moved each day as the pavement could be travelled on.

The loading plant was then moved to Jefferson. The end of the job was 2½ miles from this point. The 3½ miles remaining was constructed from here as described above.

The truck hauling was let to a trucking contractor for so much a batch-box mile. He placed on the job six 5-ton trucks and six 8-ton trailers. The trucks carried 3 batch boxes and the trailers carried 4. The batch boxes contained a 6-bag batch of 1:1½:3 mix. This outfit supplied the mixers to capacity (about 40 batches per hour) easily, at the average haul of 4.35 miles. On the maximum haul of 6 miles they were pushed to the limit and another truck and trailer were really needed, but inasmuch as this maximum of 6 miles endured for only a short time, the extra outfit was not used. On the 6-mile haul the outfits made 7 round-trips per 10-hr. day. Allowing the 7½ minutes to load and 7½ minutes to transfer the batch boxes, the trucks travelled about an average of 10 miles per hour.

The average haul on the narrow gauge track was 1½ miles, the maximum haul, 2 miles. The equipment was split into 3 trains of 7 to 9 cars each. The locomotives were left attached to the train at the mixer, shifting cars there. At the transfer point the locomotives switched to the extra train. This outfit could at all hauls easily supply the mixer to capacity. By the liberal use of sand, the locomotives were able to haul nine-car trains over 5 and 5.9% grades.





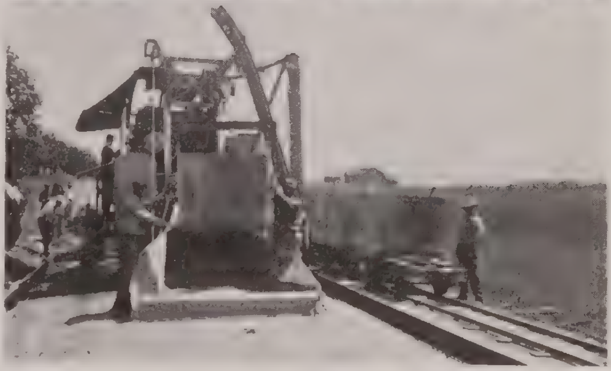


*Fig. 1—The transfer plant*

*Fig. 2—Subgrade preparation on Niles-Ashtabula road*

*Fig. 3—At the mixer*

The general method of operation was as follows: The 7 batch boxes on truck and trailer were loaded at the proportioning yard. The stone and sand from an overhead bin of about 100-tons capacity. This was kept loaded by a gasoline crane. The placing of cement was from cars or the cement shed. This work was contracted to one man at so much a sack and he with 4 helpers took care of the work. Four men with the crane operator and a foreman handled the stone and sand. It took an average of 7½ minutes to load 7 batch boxes.

The batch boxes were then hauled to a transfer point at the beginning of the narrow gauge track and transferred from the trucks to the industrial road cars.

The transfer equipment, designed by the contractors, consisted of an Ingersoll Rand Type D, 2-ton air hoist, mounted on an 8-in. steel I-beam, supported by two A frames on each side of the road. An air compressor mounted on a Ford truck supplied the air for its operation.

The transfer was moved on two 6 x 6 timbers placed on top of the batch boxes on one of the trucks. It generally took an hour and a half to move.

From the transfer point, the batches were hauled over the narrow gauge track to the mixer. Transferred from the cars to the skip of the mixer by a small derrick mounted on the mixer. The weight of the descending skip furnished the necessary power.

At the transfer point 4 men and a foreman were used. Two locomotives comprised the train crew. An average of

600-ft. of track had to be taken up and relayed each day. Six men and a foreman did this work and maintained the track. At the mixer 3 men were required to shift the boxes from cars to skip and back to cars.

The contractors started this work April 23, and were on it 185 days. On 135 days concreting was done.

15 days were lost on account of rain.
7 days were lost moving material proportioning yard.
1 day was lost on account of no material.
26 Sundays and the 4th of July the outfit did not work.

The average run for the 135 days that the mixer was started was 586-ft. The maximum run was 903 ft. in 11 hours. The best run was 878 ft. in 10 hours.

On July 1, the contractors were 9,000 ft. behind their schedule, but they finished a week ahead of it. They estimated they could not have worked 50% of the time with any other method of hauling.

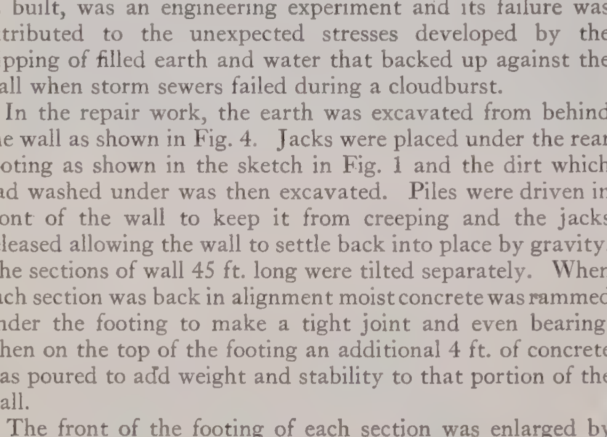
# Reinforcing a Damaged Retaining Wall

Jacks were used successfully in the re-alignment of the sections of a reinforced concrete retaining wall on the campus of the University of Minnesota. Sections 28 ft. high and 45 ft. long were tilted into line after they had been forced apart and nearly 3 ft. out of perpendicular at the top. The wall, as built, was an engineering experiment and its failure was attributed to the unexpected stresses developed by the slipping of filled earth and water that backed up against the wall when storm sewers failed during a cloudburst.

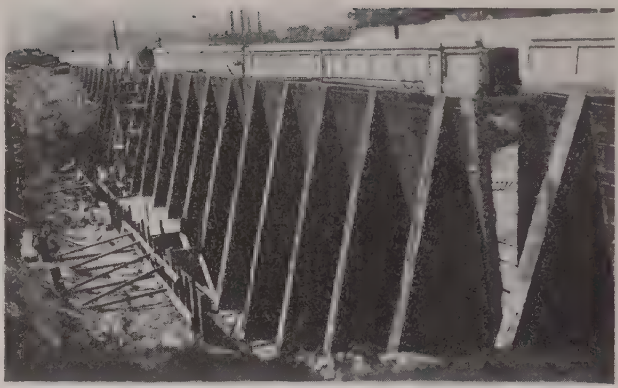
In the repair work, the earth was excavated from behind the wall as shown in Fig. 4. Jacks were placed under the rear footing as shown in the sketch in Fig. 1 and the dirt which had washed under was then excavated. Piles were driven in front of the wall to keep it from creeping and the jacks released allowing the wall to settle back into place by gravity. The sections of wall 45 ft. long were tilted separately. When each section was back in alignment moist concrete was rammed under the footing to make a tight joint and even bearing. Then on the top of the footing an additional 4 ft. of concrete was poured to add weight and stability to that portion of the wall.

The front of the footing of each section was enlarged by digging out a section 10 ft. long and pouring in 2½ ft. of concrete as shown in Fig. 3. The top of the enlarged footing now rests on the piles which had been driven to keep the wall from creeping when the sections were brought into alignment.

The total length of the wall is 650 ft. and each section weighed about 250 tons. The load on the jacks was so great that threads were stripped in some cases. Part of a section that was warped out of place was drilled away and repoured with larger footings. This operation is shown in Fig. 5, the reinforcing steel being visible where the concrete is cut away. The total estimated cost of the repairs was $20,000.



*Figs. 1-3—Sketches showing the arrangement of jacks under the footing, outline of the original footing, and the enlarged section of footing with piles driven to prevent slipping of the base.*



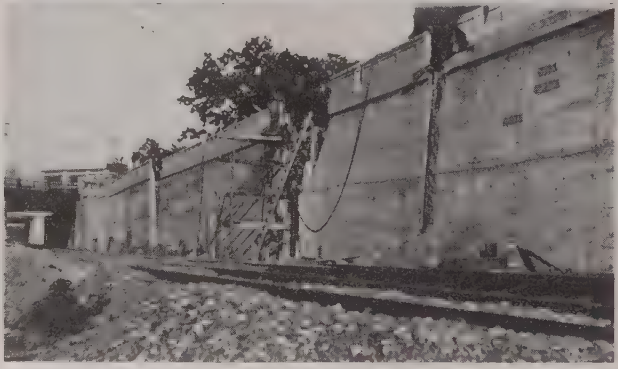


*Fig. 4—Rear view of the wall with earth excavated and additional footing course partly poured. The section on the extreme right is still out of line, the gap between it and the next section being about 3 ft.*

*Fig. 5—Front view of wall. Men are drilling away a part of the section that was badly warped*

# Sandusky Company Builds Concrete Houses

The Sandusky Cement Co. has been building concrete masonry houses at its plant at Silica, near Toledo, Ohio, for the use of foremen and plant executives, and they are to be rented to them at a merely nominal figure.

For foundations monolithic concrete is used, upon which is placed the superstructure of rough-faced concrete block. The exterior finish is of stucco of varying texture, while the inside walls are furred and plastered. Each house has six rooms consisting of a living room, dining room, kitchen, two bedrooms and a bath. The entire space below is excavated, thus forming a roomy basement, which is floored with concrete, modern in plan and equipment.

"The houses were designed and built under the direction of the engineering department of the company," stated W. T. Groner, superintendent of the Silica plant, "which enabled us to work out our own ideas without hindrance." At first it was planned to erect the houses on grounds adjacent to the plant, but a later decision changed the location to a point a mile away. A tract of land near the bungalows will probably be leveled and improved with a park with a club house, tennis courts and other provisions for recreation. While the houses are similar in plan, monotony in exteriors has been avoided by making the front elevation of each house different from the others, and by coloring the stucco in varying shades."

# Strengthening Cast Iron Bridge with Concrete

A novel use of reinforced concrete is that adopted in the repair of La Volute viaduct on the P. L. M. R. R. in South France. The bridge in question which carries a single track and consists of five spans of 182 ft. is constructed of cast iron on the familiar arch rib principle which was much in vogue in the early days of railroad construction. It had been known to be defective for some time principally on account of faults in the original design. Part of the work consisted in the removal of defective cast iron bracing and replacing this by steel bracing while steel rods as shown at *a-a'* in Fig. 1 were provided to give additional strength to the ribs themselves. The part of the work, however, which is of special interest in the present connection is that of the slabs of reinforced concrete the purpose of which is to connect together the ribs along both soffit and extrados as shown at *b* and *c* the reinforced concrete platform *j* under the rails as shown in Fig. 2 and the casing of the spandrel bracings as shown at *d* and *e* (Fig. 1). The slab at the soffit *b* has, it will be observed, a thickness of 4 in. increased at the location of the ribs, the reinforcement consisting of two layers 2.6 in. apart denoted by *f* and *g*. The lower layer *f* consists of ½-in. rods which pass underneath the flanges of the ribs while the ½-in. rods as shown at *f'*, pass through the rib at *h*, being firmly wedged at this point. Longitudinal reinforcement running at right angles to rods *f* consist of ¼-in. bars shored 8 in. on centers but this is increased at the arch centers by additional 1-in. rods 8 in. on centers.

Rods *g* of the upper layer consist of ¼-in. bars 8 in. on centers, both longitudinally and transversely.

Referring to Fig. 2 which shows a section at the center as opposed to Fig. 1 which is a section at the spring line, the slab *j* takes the place of slab *c* and is continued right across under the rails whereas slab *c* it might be mentioned is not continuous over the whole length of the arch but is stopped off 20 ft. from the end of each span. It serves as a support for the casing of the spandrel members and is reinforced like slab *b*.

Slag *j* however has a thickness of 6¼ in. It is strengthened by the transverse ribs *k*, a section of which is given in Fig. 3. These ribs, placed at 43-in. centers, are 8 in. thick and 19½ in. deep, the reinforcement consisting of two ⅞-in. bars outside and two ½-in. bars inside with the usual system of ¼-in. ties. The ⅞-in. bars run through the intermediate and side ribs being wedged in the first named and bolted in the second, there being four ribs in all. In order to assure transverse stability at the ends—the slabs cannot be connected to the piers by reason of expansion movements—the last six sets of the spandrel bracing *d* and *e*, Fig. 1, have been encased with reinforced concrete, Fig. 4 giving the essential details of this work.

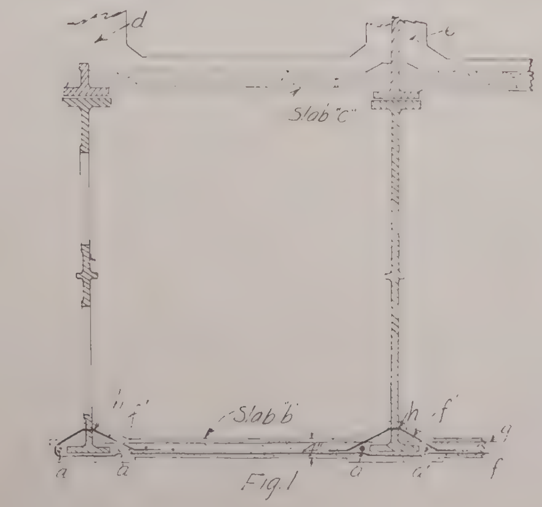


Fig. 1—Section at spring line

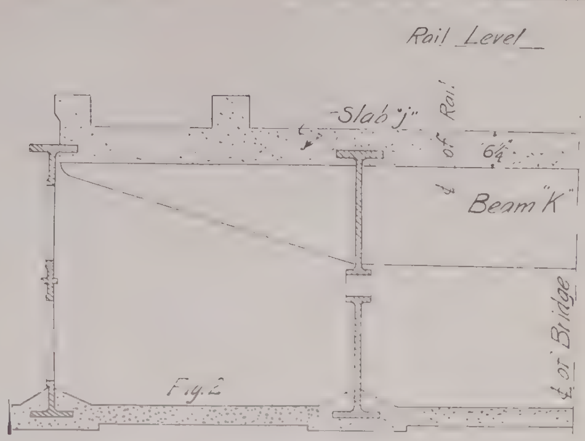
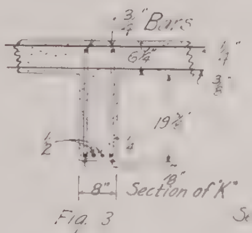


Fig. 2—Section at center



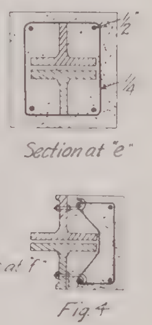


Fig. 3—Section of beam "K"

Fig. 4—Sections at "e" and "f"

When complete the work stood up under severe tests and is of considerable interest to concrete engineers as showing how metal structures which have become defective or incapable of carrying modern loads may be considerably strengthened by the use of ferro concrete. The cost is comparatively small and the existing iron work need not be disturbed, in fact, the major portion of it may be perfectly sound.

## Crazing

That the fine cracks in sound concrete may be due to weathering, is borne out by the fact that the marks appear only on the exposed faces of the concrete stone, according to Frank Jay, an English concrete worker. Artificial stones almost without exception contain lime, usually as carbonate; this lime is dissolved out by the carbonic acid and moisture in the atmosphere, and a net work of what appear to be fine cracks results; these markings are not really cracks, but only the hidden grain of the stone brought to the surface by etching. Pavements made of artificial stone do not show these markings because the wear and tear of the traffic constantly exposes a new surface.

# Cooperation of Manufacturers and Inspectors

In Wisconsin under a state law and in Columbus, Ohio, under a city ordinance may be found working examples of cooperation between concrete building unit manufacturers and the building authorities. As soon as a sufficient number of manufacturers realize that a building inspection system properly administered is their best friend, their best protection against the ignorant or unprincipled producer who competes with a low quality product, such cooperation is possible as works out greatly to the advantage of the public and to the producer.

Bert Walter, Inspector of Buildings, Columbus, Ohio, writes CONCRETE:

> The manufacture of concrete building units in Columbus is regulated by an ordinance which requires this department to select three samples from each manufacturer at least every six months. The samples must meet the following requirements when tested—viz: a compression test of 1,000 lbs. to the sq. in. and absorption test of not more than 10% by weight.
>
> We have been very successful in the enforcement of this law, and have had the cooperation of the majority of the manufacturers. I believe we have had only two cases where we have compelled the manufacturer to stop manufacturing, and one case where we ordered the block destroyed.

But that isn't all the story. There was a time when the building department under another inspector paid less attention to the concrete product men. At the time a change was made there were in operation in Columbus about twenty concrete products plants manufacturing concrete block, and they were all doing land-office business and while the building code demanded a crushing strength of 1,000 lbs. to the sq. in. and an absorption test of not over 10%, little attention was paid to it.

The new building inspector started to enforce the code by testing samples of all the block in the city. Out of eighteen or twenty tests, only three fell down, and one of the three the producer with the big stock. This made the block men wake up. Formerly they had had an association, but never got together. After this happened, a meeting of the concrete block men was called there in the city, and every man turned out. The building inspector was invited down to their meeting and he gave them a talk, and told them just exactly what he expected. They decided then that they would test the material of which they were making their block.

Unfortunately, the majority of them at the time were using a limestone screening from a local quarry, in which there was more or less loam and too much dust. The consequence was that the majority of them quit using this limestone dust and got to buying a better grade of washed sand and gravel. So that on the next test 95% of the block tested were not broken.

The present building inspector, Bert Walters, has been in office now for over a year, and he or his assistant, Sam Roberts, generally attends the concrete products meetings every month and gives the men a talk, and they have every concrete block man in the city working for the building department, and the building inspectors in turn working with the concrete products men to give the public good products. When a grievance arises between the building department and the concrete products men, the inspectors cooperate to solve the difficulty. There is no antagonism.

In one instance in the summer of 1924, a manufacturer started slashing prices. There was a strong suspicion he was also slashing quality and leaving out most of the cement. Tests made showed less than 500 lbs. crushing strength with the result that 20,000 block were condemned in the yard at the time, and no more block could be made until the low quality block were hauled away. New block tested at 14 days showed 785 pounds strength and these were rejected. This was a severe penalty but it is said now that every plant in Columbus makes block testing from 1,000 to 1,500 pounds.

Some concrete products men feel that the building departments are trying to give them the worst of it and as soon as they get acquainted and the inspectors find out that the concrete products men are willing to do the right thing and that the building department wants to help concrete products, business is just that much advanced.

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# Fifth International Road Congress

The fifth International Road Congress will meet at Milan, Italy, at the invitation of the Italian Government from September 6 to 13,1926. This announcement is made by M. LeGavrian, Secretary General of the Permanent International Association of Road Congresses, through the Bureau of Public Roads, United States Department of Agriculture.

The program announced for the Congress will include discussions of the following questions:

First Section: Construction and Maintenance. Concrete Roads—Progress achieved in the use of materials for the construction of roads in cement-concrete.

Bituminous and Asphaltic Roads. Qualities required of the materials employed: binder, aggregate.

Standardization of tests for the following road materials: coal-tar, bitumens, and asphalts.

Second Section: Traffic and Administration. Census of Traffic. Search for uniform international bases for adoption in every country.

Development and planning of towns in interests of traffic. Progress achieved in the general control of traffic in towns.

Special Roads Reserved for Motor Traffic. What conditions justify their being built; the appropriate authorities for their initiation and constructing; financial arrangements; contribution from public funds; tolls; rules for traffic circulation and for exploitation; relationship and connection between motor-roads and other highways, in the interests of safety and the continuity of traffic generally.

An international exposition open to manufacturers or producers of materials and implements used in the construction and maintenance of roads, as well as to manufacturers of vehicles and accessories, will be held in connection with the Congress.

The Italian Committee of Organization, in cooperation with the Executive Bureau of the Permanent International Association of Road Congresses, has arranged, in addition to the regular sessions, for a series of visits to modern roads built or under construction, notably the Autodrome of Monza where a race for the grand prize will be run, and the new automobile highways which connect Milan with the Italian Lakes. Visits are also scheduled to industrial plants and road construction projects which will be under way at the time.

Information concerning the exposition may be obtained from the Secretariat de la Commission Italiene d'organization du Veme Congres international de la Route, Via Sala 3, Milan (M. l'Ingenieur G. Lori, Secretaire General) or the Secretariat de l'Association Internationale Permanente des Congress de la Route, 1 Avenue d'Iena, Paris.

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It is quite generally conceded that there is only one correct way to take care of cement bags on the job, and that is to shake them well and put them in a dry place where they can be locked up. It has been the experience of some contractors that there is no profit derived from doing anything to bags after the cement is put into the mixer. Some engineers consider that cement shaken from bags that have been emptied is coarse and lumpy and not suitable for use except on mass construction where lean mixtures are permited.

# Cement Concrete Pavements

## *Modern Developments in Methods of Constructing and Maintaining*

*By Leon Belknap*
ENGINEER-MANAGER, OAKLAND COUNTY ROAD COMMISSION, MICHIGAN

Presented at the Eleventh Annual Conference on Highway Engineering at the University of Michigan on February 17, 1925.

There has been considerable development in the past few years in the methods of constructing and maintaining cement concrete pavements. This has been due to a process of evolution in several directions. First, an ever increasing demand for this type of road surface as manifested by the mileage built each year. Second, the cost of construction and maintenance of highways are problems in which the public are vitally interested. Third, a decided improvement in the design and construction of road building equipment. Fourth, the design of cement concrete pavements has been undergoing changes in an attempt to not only build a more balanced structure but also to provide more economy in its construction. Fifth, specifications have become more rigid in some respects and the results show a decided improvement. As improved methods are obtained in the handling of materials, then good pavements can be built cheaper and more mileage is the result.

The methods involved are primarily a contractor's problem. His success financially depends upon the time spent in analyzing every item of the proposed work and the skill by which he assembles the units of his organization into a smooth working whole. Such problems as the source of materials, transportation, plant layout, water supply, gradients, soils, handling of materials, local labor supply and wages, time limit of contract, equipment, capital investment, etc. must be carefully considered to insure success. He estimates the cost of building a proposed highway after having carefully considered each item and adds a reasonable profit for doing the work. Contractors who bid on highway work and use for a basis of their bids what other road work sold for are in a measure guessing instead of analyzing all the features connected with the new work. He, however, should build in such a manner that a demand for his services are created. His reputation for skill, reliability and integrity will not be judged entirely by how much profit he received from his work but by how well the work was performed.

Contracting is perhaps more highly competitive than the manufacturing business and the manufacturer of road building equipment must remember that the ultimate test of his equipment is its final cost. That the manufacturers are keeping pace with progress in road building was evidenced at a recent machinery exhibition. Refinements of construction to insure long life, dependability and economical operation were apparent. Heavy duty units with enclosed bearings, force feed oiling systems and ease of inspection and repair of vital parts were very noticeable. Tractor equipment with increased horse-power for heavy duty machines in order to make this class of equipment more mobile for highway purposes as well as lighter equipment designed for tractor operation and a preponderance of gasoline driven machinery over steam were very evident, thus showing a tendency to supplant methods in use heretofore. Improved machinery has a large part to play in successful road building operations.

To say that one particular method is more successful than another in the construction of cement concrete pavement is rather a broad assertion. Each concrete road job is an individual problem by itself and should be so analyzed. Methods that work to good advantage on one job may be entirely inadequate on another. It is not the purpose of this paper to divulge any so-called best methods in the construction of cement concrete roads but to canvass to some extent the various methods in use.

### SUBGRADE

The building of a proper subgrade for hard surface pavements requires considerable care in the manipulation of the earthwork. In general the earth grade is first brought to a flat section with ditches roughed out and the width of grade possibly 6 in. wider than the finished section. The flat subgrade is then channeled to the required depth and the fine grading completed. If the plans call for a layer of granular or porous material to be placed on the subgrade where a clay soil exists, then the proper provisions must be made in the grading to allow for the addition of this material so as to conform to the subgrade elevation. Some contractors seem to grade only for the pavement section and complete the shoulders and ditches after the pavement is completed. This latter method requires considerable end movements of earth and does not permit of the proper balancing of earthwork at the time of grading.

Slips and fresnoes are still useful equipment for short hauls up to approximately 300 ft. Hauls up to 700 ft. are usually best accomplished by use of wheeled scrapers and longer hauls by wagons or trucks, loaded by means of an elevating grader pulled by a tractor, or by steam shovels. The steam shovel is in more common use in Michigan and with trucks or teams and wagons overlaps the wheeler hauls especially when large quantities of earthwork are involved. Gasoline tractors are used for hauling straight blade graders, scarifiing, rooting, plowing and the loading and hauling of four wheeled scrapers and otherwise displacing teams for this work to some extent.

Special emphasis should be made in preparing the subgrade in such a manner as to provide as uniform a support for the pavement as possible. All springy spots should be properly drained and refilled with dry material. The hard surfaces of old roads should be plowed to a depth of 6 in. and then compacted.

Machinery has supplanted the pick and shovel gangs in fine grading to a large extent. Although there is still need for hand labor for final cleaning up, the heavy part of the work can be accomplished by machinery. Gasoline tractors of the crawler type attached to a heavy blade grader and scarifier will remove the bulk of the earth in the channel. After forms are set a subgrade machine riding on the forms will cut the exact crown of the road bed. A gasoline roller pulls the subgrade machine and compacts the subgrade at the same time. The subgrade is finally checked by a template. Nails, driven in the bottom edge of the template to the crown of the subgrade, as the template moves along the side forms indicate by scratches the high spots.

### CONSTRUCTION

*Forms*—The use of wooden side forms was permitted a few years ago but since smoother pavements and better alignments are required this type of form has been eliminated. The use of subgraders and heavy finishing machines has required more rigid forms with proper foundation support. In some soils it may become necessary to increase the bearing support of the forms by the addition of short pieces of lumber. Heavy equipment may cause the forms to sink and thereby reduce the thickness of the pavement appreciably as well as producing a wavy surface. Too much care cannot be taken in this regard if smooth pavements are obtained. A rough surface often blamed to uneven aggregate and improper mixing may be tracable to a lack of proper forms and the alignment and bearing for the same. The new pavement section with thickened edge has required the use of side forms nine inches deep.

*Proportioning of Materials*—The supply of raw material, sand, gravel or crushed stone and cement is usually supplied through railroad transportation from some distant point. The problem of unloading cars and proportioning materials is interwoven with the method of mixing operations. The latter consists of several methods: first a central proportioning plant; second, a central mixing plant or a modification of the same and third, the wheel barrow method. The wheelbarrow method of proportioning aggregates was used almost entirely a few years ago. The measure of materials was done by gauging the load on the wheelbarrows and then dumping into the skip of the mixer. The number of loads of each aggregate was counted to get the correct amount in each batch. Later batch boxes were used on belt conveyors, which conveyed the material to the mixer. This method has been largely discontinued because of the increased cost of labor and loss of material on the subgrade as well as objections to dirty aggregate, which was occasionally delivered to the mixer. Proportioning of material at a central plant is a later development. Coarse and fine aggregates are unloaded from the cars by means of a clam with ¾ to 1-yd. buckets and loaded into elevated bins. These bins are provided with measuring boxes so that proper proportions can be delivered to the hauling equipment. Where drop-bottom railroad cars are obtained, a bucket elevator is sometimes used to good advantage. Occasionally contractors devise other means of unloading cars and loading trucks or batch boxes. Set-ups have been observed where material from drop-bottom cars was unloaded into bins built under railroad trestles. Tunnels are frequently used which provide for easy access by trucks or industrial cars under stock piles. Measuring boxes are provided in each case. Cement is shipped in sacks and requires separate storage at a convenient point where it can be readily placed on the trucks or in batch boxes. Bulk cement might be handled to a greater advantage with a central mixing plant or proportioned by weight and deposited in separate compartments of batch boxes. It has been discovered that the volume of sand is affected by the moisture content and in some cases compensation is made on account of this by altering the capacity of the measuring box. A central mixing plant simply consists of rearranging the proportioning plant so as to discharge into a mixer and the wet batch hauled on to the road. Modifications of this layout according to the contractors idea of arrangement have been made. Stock piles have been placed at various intervals along the highway and the mixer moved from stock pile to stock pile with the wet batches then hauled to the road.

*Transportation of Materials*—There are in general two methods of hauling materials to the mixer located on the subgrade. First, hauls made by a truck over the subgrade; second, hauls made by industrial equipment, or a combination of both methods. The adaptability of the above methods seems to vary with the whim of the contractor where either method might apply. Industrial haulage by means of gasoline locomotives, cars and light narrow gauge track is confined to minimum grades and the amount of material that can be hauled by each train is limited by the maximum grade over which it is hauled. Batch boxes, two in number, for each car are loaded at the proportioning plant, hauled to the mixer and have either bottom or side dumps or are tilted when unloaded. The tracks are usually placed on the shoulder of the road with convenient switches and at least one switch placed near the mixer so as to delay mixing operations as little as possible. If the mixer works away from the source of supply, then advantage may be taken of the finished portion of the pavement by placing the track on the pavement.

Trucks hauling materials to the mixer are in quite common use. These vary from the heavy 5-ton truck to light truck with pneumatic tires. Heavy trucks are used more frequently in hauling material to a central stock pile rather than to a mixer because of damage to the subgrade, which may require additional fine grading. In general trucks can be used on steeper grades than industrial equipment and where soil conditions permit are more mobile and can take advantage of side roads where it would not pay to be continually changing industrial tracks. Oftentimes heavy trucks are used to haul materials from a proportioning plant over a road where railroad crossings, grades or other conditions prohibit industrial tracks and in this case where combined with industrial equipment flat decked trucks are used to carry batch boxes and are in turn transferred from the truck to industrial cars by means of a derrick or other apparatus. Turntables are provided for turning trucks around on the grade and inside of the forms. Planks are occasionally used near the mixer to protect the subgrade and require moving as the work progresses.

*Mixer Operations*—Mixers are now being operated by gasoline engines quite universally due to the availability of gasoline supply and the realiability of motors. The size of mixers varies somewhat although the general type is of 21 cu. ft. capacity of wet mix. The mixers are equipped with timing devices so that the required number of turns are obtained automatically. Crane devices operated by mixer engines are used to lift batch boxes from industrial cars and then dumping them into the skip. The crawler type of traction for mixers is coming more into use because of the greater ease of portability. Boom and buckets have replaced the spout delivery of mixed concrete. Reinforcing wire mesh or bars are held in position while placing concrete by means of steel forms, which forms are hauled along the subgrade after depositing of concrete by the mixer or reinforcing is held in place by bar chairs. The use of longitudinal center joints has required the use of installing devices which in addition to pins, hold the joint vertically in place. Care must be used in depositing concrete so as to load the center joint equally on both sides.

The method of installing transverse expansion joints varies somewhat in different localities. The use of a plank cut to crown of subgrade against which the joint material is placed requires the refilling of space after the plank is withdrawn and results in the joint material getting out of line either vertically or transversely across the pavement. A better installing device consists of a steel plate with V notches cut in the bottom so that the fresh concrete supports the joint on either side and when the form is withdrawn does not alter the position of joint filler and requires a minimum of additional concrete.

*Finishing of Concrete*—There are several types of finishing machines on the market, which makes it possible to finish concrete of a stiffer mix than was possible before. The machines are propelled by gasoline power and ride on the steel side forms. Automatic striking of concrete to the required crown, the tamping of concrete and the belting of the surface for final finish, are possible in one operation, although several trips of the finishing machine are generally required to produce a good surface. Hand belting methods are not entirely discarded as a good many localities use this method in addition to the finishing machine operations. Hand floats for finishing joints as well as other concrete surfaces are in use also. There is on the market a hand belting machine which is propelled by one man and gives the final belting of the concrete. This machine rides on the forms similar to the finishing machine. Longitudinal strikes or floats are used in some states to help in eliminating waves on the surface and are operated by hand from portable bridges.

Concrete pavements are now being checked by ten foot straight edges which requires the surface to be not more than ¼ in. from a smooth surface. Hand tools for rounding the edges of the slab to ½-in radius are required.

*Curing*—The methods used in curing consist of first covering the surface with burlap as soon as the pavement has hardened sufficiently so as not to injure the concrete and then kept wet until the following day. A machine has been developed that carries the rolled burlap on a circular steel drum and can be rolled off the drum and on the pavement or vice versa. The second day, the road is covered with earth to a depth of at least 2 in. or with straw to a depth of at least 3 in. and kept wet for a period of 14 days.

A later development in the curing of concrete is by the use of calcium chloride. This material is manufactured in flakes or granular particles and is shipped in 100-lb. sacks or 350-lb. drums. It can be either spread on the pavement by hand with shovels and broomed or placed with a special chloride spreader operated by one man. The quantity placed per square yard varies from 2 to 4 lbs. It is usually placed on the concrete from 12 to 24 hours after the pavement is laid. The use of chloride during the season of the year when the temperature of the atmosphere is low, or around 40°, requires the application to be delayed a sufficient length of time depending upon the speed of setting of the concrete, which may delay covering with chloride, for 36 hrs. The calcium chloride method eliminates the labor of covering and uncovering pavement with earth and the quantity of water and labor necessary to sprinkle pavement for a period of 14 days.

Contractors are required to bush hammer or otherwise remove high spots in the concrete, which exceed ¼ in when tested with a 10-ft. straight edge. There have been several attempts at devising some mechanical means of performing this work. Stone chisels operated by an air compressor to remove the excess surface and then rub down with a brick still does not provide anything but a slow tedious job. An ingenious device has been designed by an enterprising contractor in which he used a Fordson tractor with an attachment supporting a vertical shaft at the lower end of which is a circular carborundum stone. This stone is caused to rotate by means of a belt from the tractor and the grinder is easily moved around over the surface to be reduced.

## MAINTENANCE

Cement concrete pavements, like other highway surfaces, have not as yet reached the stage of perfection that maintenance may be entirely eliminated. It is safe to say that a well designed and constructed pavement of this type requires as little maintenance as any other type of road surface. The other types of cement concrete pavement, which were either laid of a thickness inadequate for present day traffic or without the advantage of research in the matter of design, requires an amount of maintenance in excess of that found necessary in a well built pavement. Frost action, poor drainage, improperly constructed subgrade and lack of maintenance at the proper time are some of the causes of failure in pavement slabs. The inclined position of joint material has caused one slab to climb higher than the adjacent slab due to expansion and in which position impact from heavily loaded vehicles cause the gradual destruction of the section and shows carelessness in construction. The placing of pavement on newly graded roads, especially where heavy cuts and fills are made and proper settlement of earth has not taken place has also tended to increase the cost of maintenance. Where the minimum width of pavement has been increased from 16 to 20 ft. there has been a decided reduction in the number of failures due to corner breaks and progressive failure of slabs. The increased width has permitted heavy trucks to travel at a greater distance from the edge of the pavement slab and is therefore less liable to do damage. Smoother surfaces have reduced the impact from heavy truck loads as well as a greater use of pneumatic tire equipment for the intermediate size of trucks. Increased motor vehicle travel near our large industrial centers has required the widening of some of the main arteries; yet there are and will be, for some time to come, many pavements 16 and 18 ft. wide, which are carrying an excessive amount of travel, and should be widened at this time. These pavements demand considerable maintenance and may fail faster than like pavements in less congested centers. In comparing the cost of maintenance of various types of pavement, the amount and character of the traffic should be considered as well as other conditions surrounding its construction.

The maintenance of cement concrete pavement as different from gravel or other types of road surface has developed a gang system of repair similar to section hands on the railroad. These gangs are equipped with light pneumatic tired trucks for ease in moving from place to place on highways. Their job is to patrol the pavement giving whatever attention is necessary at the proper time. Aside from the work required to keep weeds cut and shoulders properly repaired, the principal work necessary is to tar all cracks and joints so as to eliminate spalling and protect the subgrade from any undue moisture and the patching of broken places in the slab.

*Patching Concrete*—The broken section of the pavement must be removed and the edges of the adjoining slabs squared up so as to permit of a good bond. A little care in removing the old concrete so that few radial cracks remain is quite essential. If the patch is cut in such a manner as to give a reasonable area for transmitting of load to subgrade as well as eliminating all acute angles where bonded to the old pavement, the patch will remain a part of the pavement. The excavation for the patch should be at least an inch deeper than the original slab. An air compressor mounted on truck or trailer of sufficient capacity for operating at least two concrete breakers for reducing the broken edges of the old slab and trimming up the adjoining edges saves considerable time and labor over the old hand method of handling chisels. Where a considerable amount of concrete is to be broken out, some form of drop hammer mounted on a truck may work to better advantage. The old concrete can be broken up and removed in a few hours in sufficient quantity to keep a gang patching all day. Side forms should be placed and securely staked to a depth at least equal to the old pavement. Material sand, gravel and cement is deposited by means of trucks on one side of the pavement near the slab. A portable mixer of 7 cu. ft. capacity, with roller bearings and rubber tires usually works to a good advantage in the ordinary patching work. It does not take up very much space on the highway and is easily moved from patch to patch by a small truck.

The aggregate is wheeled to the mixer in wheelbarrows. Water is supplied in barrels or tank wagons filled at some convenient point. A central mixing plant if convenient to the work is sometimes used so as not to obstruct traffic. It being necessary on most concrete roads to patch only one side of the pavement at a time and to leave some distance between patches so as to facilitate the movement of traffic. The patch should be struck off and finished to a smooth surface with the adjoining slab as consistent with good practice in original construction.

Calcium chloride dissolved in the mixing water is quite desirable in the patching of pavement. Two to 4% of this material by weight is found to be the correct proportion, the variation in amount depending on the temperature of the atmosphere. Patches which heretofore were kept closed for 21 days can be opened within a week without damage to the concrete. This represents quite a saving in watchman service, broken lanterns and barricades. The recent development of aluminate cement in this country may further reduce the cost to traffic in delay and accident hazards where used in patching, as this cement sets in 24 hours.

*Tarring Cracks and Joints*—The small portable tar kettle of the capacity sufficient to hold at least 2 bbls. of tar, with hand pouring pots, brooms and sufficient sand to cover the fresh tar, are some of the requisites of this part of the work. Barrels of tar may be distributed along the highway as well as small piles of sand. A good combination for tarring cracks consists of a truck loaded with sand which pulls a tar kettle slowly along as the work progresses. One man sweeps out all the dirt from the cracks while a second man pours the joint and the third man covers the fresh tar with sand so that it does not pick up with wheel traffic.

A later development in the method of handling tar consists of a stationary tank sufficient to hold 15,000 to 20,000 gals. in a central yard where tar may be handled in tank car lots by means of a pump and steam heat. The tar can be preheated before the gang starts out on the road so as to avoid delay in commencing operations. A portable tank sufficient to hold the day's requirements may then be carried on the truck or trailer. There is considerable saving in the cost of tar as well as time lost in the handling of tar in barrels by this method. Asphalt may be used with success instead of tar for the pouring of cracks and joints although the writer has had very little experience with this material. There would be very little difference in the method of handling either.

### CONCLUSION

In conclusion it has been shown that the construction and maintenance of cement concrete pavement has resulted in an increased use of motor traction and power equipment. This has been due in a great measure to the manufacturer who has made wonderful progress in the designing and construction of machinery to supplant man power and the perfection of that machinery so as to insure long life, dependability and economical operation. The contractors in turn have perfected organizations, the nucleus of which at least are carried on the payroll the year round, to an extent that production can be carried out with a minimum of direction.

The necessary skilled labor for work of this character is more plentiful, due to an increasing amount of road work being carried on and new hands learning the trade. The successful contractor takes better care of his equipment, maintains yards and repair shops so that first class equipment furnishes better work at less cost and delay, and makes workable methods that reduce hand power and team power to a minimum and otherwise guarantee a satisfactory season's performance.

# Heavy Concrete Dam Repaired with Guncrete

The pictures herewith illustrate a rather unique piece of work in solidifying and protecting against further damage a heavy concrete structure. The success which has attended the effort is another argument in favor of concrete, in that it shows that inherent defects in a mass concrete structure can be remedied even under extremely adverse conditions. Fig. 1 shows a cross section of a gravity concrete dam across the St. Croix River in Maine.

For purpose of water-level control, concrete brackets 5 ft. apart, 10 in. thick, were cast on top of the main structure on which 2 x 10-in. planks were laid loose. There was always more or less leakage through the cracks between these planks, which was in part stopped by throwing boiler cinders into the water and allowing the fill to silt up these cracks.

Due to difficulties of constructing this dam in extremely cold weather, there were inherent defects in the dam which permitted a large amount of leakage, through the body of the structure. This amounted in volume all the way from a trickle, due to seepage, to actual streams spurting out to some distance. This is well shown in Figs. 2, 3 and 4 where the white parts are water, and only the dark portions of the pictures show moist surfaces.

The action of frost during a period of years on both the water coming through the flash-boards and running down over the downstream face, and on the water passing through the body of the dam, was such as to tear away large parts of the concrete on the downstream face, this damage being progressively worse each winter.

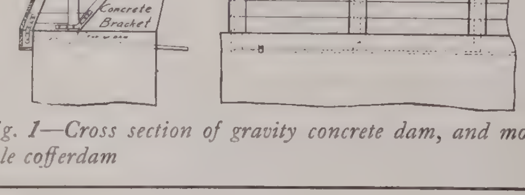


*Fig. 1—Cross section of gravity concrete dam, and movable cofferdam*

Investigation by a diver showed no such deterioration on the upstream face which was continuously under water below the bottom line of flash-boards.

The first thought was to fill up the holes on the downstream face and then cover the surface with a smooth facing by means of cement-guns. Obviously this would have been a temporary expedient of very questionable value so long as the body of the dam was saturated with water. This water would freeze and push off the Guncrete facing.

To dewater the lake above the dam was ruinously expensive, and to cofferdam the upstream face was a matter of extreme difficulty owing to the water logged timber and other rubbish that had accumulated. It was decided to try to solidify the body of the dam by impregnating it with cement grout.

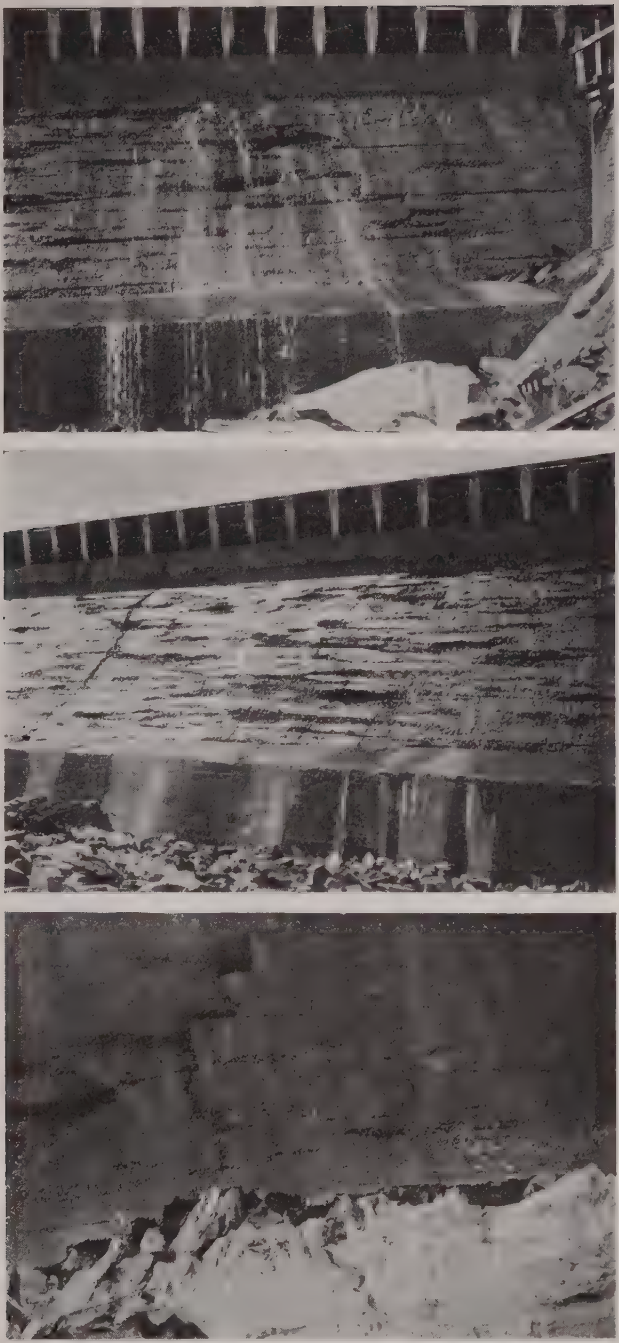
One of the difficulties anticipated was the matter of slime which covered the downstream face and extended into the cracks and crevices to an unknown depth. This slime would have to be removed before the impregnating cement or grout would bond to the old concrete.

Another difficulty was the stoppage, on the downstream face, of leakage through the flash-boards.

Fig. 1 shows a movable cofferdam that was built in 16-ft. sections and floated into place. The pressure of the water held it firmly in place after removing the flash-boards, and what little leakage there was through the cofferdam was gathered into the gutter and piped free of the downstream face with a 2-in iron pipe.

By a process of impregnation under heavy air pressure, the structure was first cleared of slime with a weak solution of potassium permanganate, which almost instantly oxidized the slime wherever found, leaving clean surfaces. Cement grout with various admixtures of accelerating or retarding compounds was then forced in until the downstream face was entirely dry.

The dam consisted of two wings at right angles to each



*Figs. 2, 3 and 4—Views of down stream face of dam, showing water seeping through mass of structure*

other, one about 300 ft. long and the other about 1200 ft. long. It was the short leg of the dam that was the worst, so this was treated first.

Fig. 5 shows the downstream face of the dam as it was completed November 1st, 1924. Only that portion extending up to the right angle was treated.

The grouting process was continued until all leakage and seepage stopped, so that the downstream face was dry.

Reinforcing mesh and rods were then secured to the face by means of anchor bolts. Concrete, consisting of one part portland cement and three and one-half parts of sand, was then shot in place, filling all cavities and coating the entire surface as shown in the picture.

Before applying the Guncrete it was quite definitely shown by various investigations that porosities, cracks and crevices were definitely filled and sealed. It is believed therefore that not only is the downstream face thoroughly protected against further action of frost due to penetration of water flowing over the downstream face through the flash-boards, but the body of the dam is now thoroughly solidified and truly monolithic.

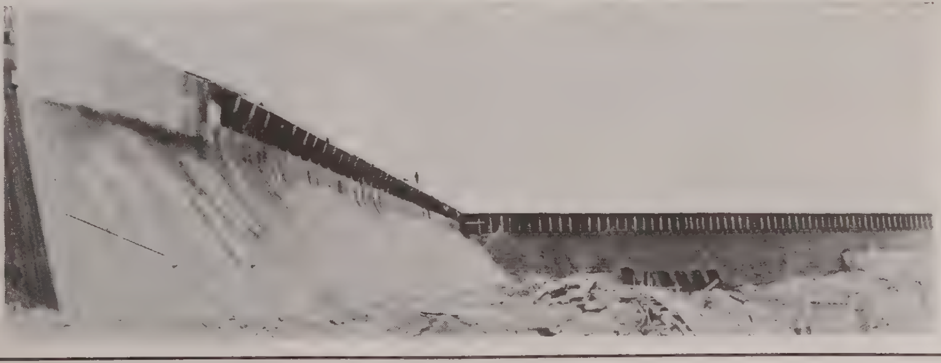
All the work was done by the Cement-Gun Construction Co., of Chicago and Pittsburgh, to whom CONCRETE is indebted for this description and the illustrations.

## Liquid Celluloid to Coat Molds

Liquid celluloid, employed as a coating for wood and plaster molds, for concrete casts was mentioned recently by Charles Marques, in a letter to CONCRETE and requests for further information bring the following in a letter from Mr. Marques:

> What we know as "Dope," is a liquid celluloid and I believe it obtained its abbreviated name while being extensively used as waterproofing for aeroplane fabrics etc., during the war.
>
> Realizing its imperviousness to both oil and water and knowing that cement would not adhere to sheet celluloid, I made many experiments with it (obtaining the solution from the British Cellulose & Chemical Manufacturing Co. Ltd., of Spondon, near Derby, England, at 21 shillings per gallon). I find that when used thinly on good dry wood it is a good pore filler and leaves a fine surface. Have used it extensively with varying success on both wood and plaster, any failures being attributable to sap in the wood or moisture in the plaster. It can be mixed with ordinary whitening to a putty to fill cracks or to level off inequalities such as shrunken knots, etc. Sappy wood should have a preliminary wash of methylated spirits (adulterated alcohol) to evaporate the moisture.
>
> Its shrinkage when drying is its greatest fault for if applied thickly it has a tendency to lift itself from internal angles.
>
> Second or subsequent applications have to be applied quickly as it dissolves the previous coatings.
>
> In some cases I have had well dried whitening ground into the liquid with the idea of lessening the shrinkage and in all probability such fillers as zinc or barium oxide would have better effect.
>
> The cellulose will dissolve any spirit varnish previously applied and create clots that will spoil the surface. A thin solution can be applied to fill the surfaces of dry made concrete if required as a mold, oiling the surface before casting.
>
> Am now experimenting with a new substance—Mettallon metal paints mixed with a secret preparation, which after drying can be polished to metal surfaces.

*Fig. 5—Downstream face of dam after treatment with Guncrete*



# What Is Good Concrete?

This is an editorial from *Engineering News-Record.* It is interesting because it carried not only an expressed understanding of the weaknesses of the material concrete and the urgent opportunities for further study, but sets the matter down from the viewpoint of the general engineering field.

Concrete is a universal construction material. There are specialists in its design and its making and placing but every engineer and every builder has to use a certain amount of it and has to have, or at least ought to have, more than a rudimentary knowledge of its necessities and peculiarities. No subject is more widely discussed when raised among engineers than the making of concrete, not only because of this universality of its use but because concrete itself is neither completely satisfactory in use nor completely standardized in its manner of production. Every engineer has his own observation of eccentric behavior to report and his own technique to defend—which in itself is the beginning of argument. But such argument more often than not gets nowhere or at least creates only misunderstanding because the participants do not start on a common ground. Each assumes that what he is trying to do is to make good concrete but nobody takes the trouble to define just what good concrete is.

Good concrete fundamentally is concrete which serves the purpose for which it is intended. It is not, therefore, a fixed immovable standard, but changes with conditions. Concrete plenty good enough for a dry subterranean foundation would be the poorest sort of material for a high pressure pipe line or a seawater pier. And service, varying as it does for varying structures and uses, is something more than the ability to meet a momentary condition; it is the satisfaction of all the conditions that the structure must meet during its economic life. Failure to appreciate this distinction is the natural result of the dominance of the theory of structural design in concrete.

For that theory holds strength to be the governing consideration in structures. Loads are assumed, the stresses they induce are distributed throughout the structure according to known or assumed laws and the members are proportioned to meet those stresses according to some assumption of what the given material can safely stand, an assumption predicated upon what similar material has stood either in structure of in test. Strength, the continuing strength of a homogeneous material which has the same strength everywhere, is the controlling element. All else is secondary.

Unfortunately, this strength, which has been so overemphasized in design, is the least difficult thing to assure in concrete and after all the least important of its desired qualities. Concrete failures of the kind that are called failures but which are more specifically collapses are rarely due to lack of strength. They are due to inadequate design or improper construction, to neglect of details of connections, to insufficiency of material or to obviously dangerous expedients in erection. The concrete itself, even though of low unit strength, is rarely so weak that it would not have been sufficient had proper design and construction precautions been taken. Under any normal method of design the unit strength would have to be much less than half that assumed if the concrete is actually to fail, suddenly and directly under load. Concrete has been placed so poor in quality and consequently in strength that such failure does take place, but that is just ignorance or carelessness or worse—and it is comparatively rare in important work just as poor workmanship is rare in any of the crafts.

But there are other qualities of concrete beside unit strength that structural design does not take into account and these are the qualities which are most important in making good concrete. They are the qualities which insure stability and homogeneity. They are density, and low expansibility, and high resistance to weather and to wear.

We know really very little about these qualities of concrete, that is, very little quantitatively. We know that some concrete has high resistance, that it wears well under adverse exposure, that it is dense and noncracking. Such concrete sometimes has a high strength and sometimes not; certainly its strength is no absolute measure of its resistance to the attacks of time as it is a measure of ability to withstand load. We know that other concrete of high strength and early admirable appearance succumbs to the attack of time long before it succumbs to the continuing pressure of load. There is a relation, of course, between strength and wear. By and large, the strongest concrete will resist other attack best, but it is by no means a law nor is there evidence yet of any formula by which strength and wear can be correlated.

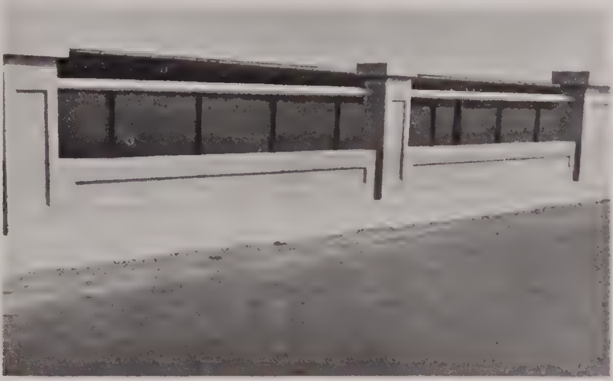
There is a distinction between designing a good concrete structure and making good concrete. It is not enough to be able to build a structure which does not fall down, nor sag nor crack under its appointed load. The builder of concrete should strive to make concrete that will stand the years as well as the tons—and if any such builder feels that this is an easy task or that to insist upon it being done is academic, let him take a few days off and make a close examination of some of the outdoor concrete he put in ten years ago.

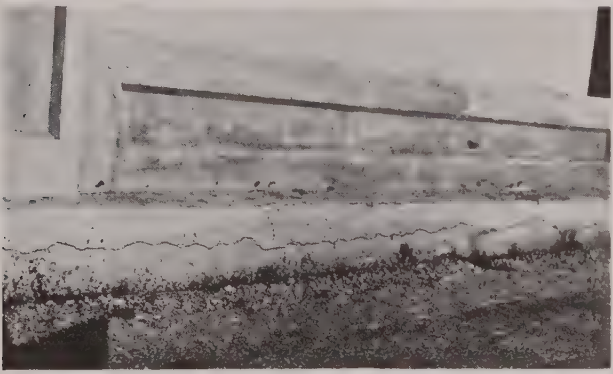
And so when we talk about good concrete we ought to agree on what we mean by the term. It is no defense of certain types of structures to say that there are no records of collapse among them, if every other one of them is in process of obvious decay, is wearing out rather than breaking down. It is little solace to the owners of a certain stadium that a piece of concrete taken from one of its columns will test 3,000 lb. per sq. in., if the structure is ugly with cracks and rods lie exposed to the rain and the sun. Good concrete is concrete which does its appointed work day in and day out, year after year, with no more change than that which takes place in a comparable natural stone, which presents a smooth-grained surface, which does not crumble and ravel. It may crack in places under excess strain there but that does not take away from it the claim to be good; it means only that its designer failed to recognize or to discover certain stress conditions. It must be as cheap as possible, and in insuring that the designer can exercise ingenuity not only in the arranging and detailing of his structure but in the selection and proportioning of his concrete materials. It must obviously be as strong as it need be and no stronger. But above all it must last through the period of its economic life, that is until it would be cheaper to replace it than to have provided for a longer life. And it must last that long in a presentable state, for in most outdoor concrete structures appearance is of great importance.

To make such good concrete is the end of all the studies that are being made toward more scientific proportioning and mixing and placing. Some of these—most of them indeed—are too complicated. They still smell too strongly of the laboratory. But that is an evil that will be overcome. There is more than a chance that the carefulness of preparation and the observance of fixed rules of manufacture which are a part of the more scientific making of concrete tend to a uniformity of product and a closer approach to an optimum product, both of which mean a concrete which, while not necessarily of greater strength, should certainly be of greater wear resistance than the best of the rule-of-thumb concrete of earlier days. And that greater wear resistance, after all, is what makes good concrete.

# Closing Cracks in a Concrete Bridge

The penetrative and destructive powers of sea air on certain types of concrete work were exemplified recently on a California bridge and interesting repair work was made necessary because of the ravages. The bridge spans Santa Margarita river and is on the Coast highway north of Oceanside, San Diego county. Engineers of the State Highway Commission, on an inspection tour, found that many cracks had appeared not only in the deck and railing but in the girders. The bridge is on the beach and tidewater washes back and forth beneath it. Consequently the air is always moist and salt.





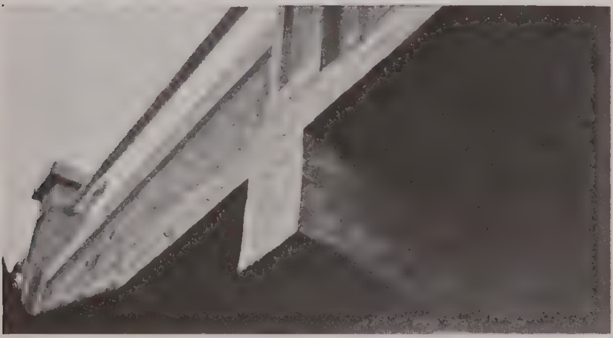
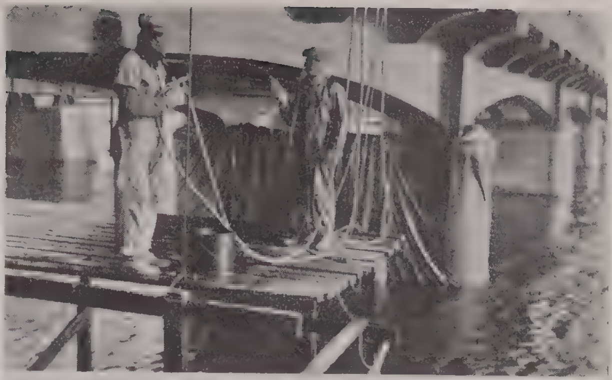
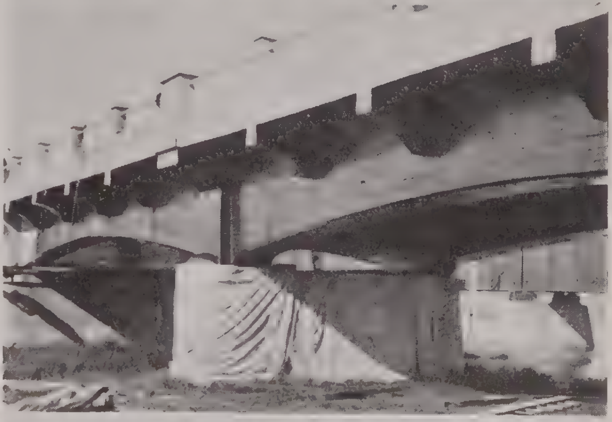


*Fig. 1—Santa Margarita bridge. Railing after painting with damp-proof paint. Existing cracks were filled with Stonetex crack filler*

*Fig. 2—Close up view of wheel guard and railing showing crack caused by rusting of reinforcing steel. Before application of damp-proof paint*

*Fig. 3—View showing cracks in deck caused by expansion of rusting steel reinforcing rods*





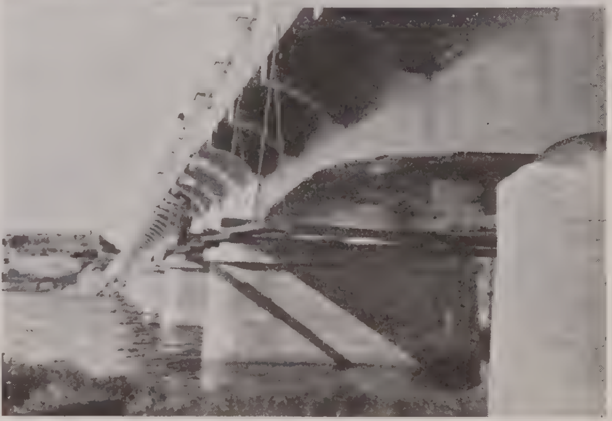


*Fig. 4—Waterproofing the Santa Margarita river bridge. Applying petrolastic cement to under portion of bridge with air brush outfit. Men wear masks to protect them from the spray*

*Fig. 5—Applying petrolastic cement to girders and under portions of bridge*

*Fig. 6—Erecting scaffolding over water where submerged piles prevented the use of raft*

The result was that the concrete was penetrated by the moisture to a considerable depth and rust had formed on the reinforcing steel bars which were presumed to be placed a safe distance beneath the surface. As the rust takes up much more space than steel, considerable swelling followed and the cracks began to show.

The engineers decided that the deterioration was more marked than in present-day construction because the bridge was built some years ago and the concrete was not of the strength required in modern structures. They reported that a complete waterproofing job was necessary.

All parts of the bridge exposed to the air at the top and sides were painted with Stonetex, a moisture proof paint,[1] which in color, texture and effect is much like concrete and has an affinity for it. The lower part of the bridge, including girders and supports received a coating of petrolastic cement. This mixture is asphalt blown by air, and is found to have more elasticity and consequently more durability than asphalt blown by steam.

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[1] Truscon Laboratories, Detroit, Mich.

A paint sprayer with two air-brushes was used to put on the petrolastic cement. All airbrush work was completed before any of the hand painting was done, to avoid possibility of marring the hand work by spattering.

The petrolastic cement was reduced to the proper consistency for application first by heat and then by the mixing in of a liquid thinner which contained 25% of benzol to 75% of mineral spirits. Experiments proved that the best mixture was two parts of the cement to one part of thinner.

The cement was applied as liberally as was necessary to seal the cracks. Over most of the surface only one coat was applied. In some places, however, the breaks were quite marked, and this area was given a second coat. Exhaustive tests revealed, after the cement had dried and hardened, that it gave a smooth and resistant waterproof covering. The requirements were about $\frac{3}{8}$ gal. per sq. yd.

Where it was possible to use it, the men operated the airbrushes from a raft. Under some of the spans, however, because of obstructions, a scaffolding was used, being hooked to the bridge railing and suspended over the water. The piers did not require waterproofing and were covered with canvas to avoid spatters of the petrolastic.

The larger cracks on the upper parts of the bridge were first filled with a special filler. Then two coats of the Stonetex dampproof paint were laid on with hand brushes. Time and pains were taken with the first coat, so that it could be brushed well into the pores of the concrete. For this coat, a liquid thinner was used in the proportion of 1/6 of the volume of the paint. The second coat, applied after three days had been allowed for drying, was not thinned. A gallon of the paint gave approximately 10 sq. yds. of surface two coats.

This painting experiment having proved a complete success, the Highway Commission ordered either painting or spraying, as conditions demanded, of the San Luis Rey river bridge at Oceanside, and of the Agua Hodienda creek bridge.

# Effect of Shrinkage in Concrete

*By A. B. MacMillan*

CHIEF ENGINEER, ABERTHAW CO., BOSTON, MASS.

In the article on the "Relation Between Reinforcement Embedment and Size of Bar" by A. S. Woodle, Jr., printed in the September, 1924, issue of CONCRETE, attention is called to the effect of temperature differences in causing surface cracks in the concrete over the embedded steel.

Admitting that temperature differences and stresses set up thereby may exist, the writer believes a greater cause of trouble is to be found in the shrinkage of the concrete surrounding the steel as it dries out after setting.

The amount of shrinkage varies with the materials used and the richness of the mix and no exact percentages can be stated.

However, in studying temperature as the cause of surface cracks over the steel, the effect of drying out and shrinkage should not be forgotten.

In general, it may be stated that the effect of shrinkage in concrete was noted by Considere some 16 or more years ago and values from .005 to .0015 in 1:3 mortar and much higher values for neat cement reported.

That the effect of shrinkage is considerable and its presence recognized may be predicated on our common every day acceptance that concrete does not adhere to the steel reinforcing bars placed therein, but grips them by contracting around them in drying out; simply another way of stating that the concrete shrinks an appreciable amount.

In reading the analysis of Mr. Woodle, Jr., in the September number of CONCRETE, in which he treats the concrete over the reinforcing bar as a bridge, it would seem that this treatment was rather incomplete. Mr. Woodle, Jr., has apparently disregarded the expansion of the bar parallel to the surface of the concrete with its tendency to cause tension and increase considerably the stresses in his concrete bridge.

He has also made the somewhat doubtful assumption of the bridge acting as a simple beam, whereas if it acted as a beam at all it would perhaps be more nearly correct to assume that the ends were fixed.

Neglecting the method of calculation, however, Mr. Woodle, Jr., uses a unit stress resulting from a deformation of $.0000005 \times 50 \times d = .000025d$; where .0000005 is the coefficient of expansion per degree of temperature, 50 is the assumed temperature change and $d$ is the diameter of the bar.

Referring to the *Proceedings* of the American Concrete Institute Volume XVII, 1921, in the paper by Franklin R. McMillan, "A Study of Column Test Data," tables showing tests made at the University of Minnesota and other test data will be found indicating an evident deformation from shrinkage of .0005 or more.

These values vary to some extent with the richness of the mix and other variables.

The value of .0005 from these tables is evidently five times as great as that used by Mr. Woodle, Jr., in his paper and should doubtless be given rather more weight as a factor in causing cracks where the bar is close to the surface than temperature, but the effect of temperature should not be neglected.

Whatever the cause it has become apparent that careful placing of reinforcement to make sure that it is at least two inches from any exterior surface exposed to heat, cold, rain and wind, must be used if we are to avoid the unsightly disintegration taking place at present on the outside of some concrete buildings.

# Coating Reinforcing Bars

Reinforcing bars in concrete construction are not exempt from the destructive influence of corrosion. Iron in direct contact with pure cement is protected because the alkalinity is then sufficient to inhibit any corrosive action. With concrete, the case is quite different, according to the Philadelphia Quartz Co. in *P's & Q's*. The cement is distributed throughout a mass of sand and coarse aggregate which frequently reduces its concentration at the surface of the iron below the danger line.

The destruction wrought by corroding bars is disastrous. As rust forms, the volume of the bar increases. Roofs collapse, important beams or compression members split wide open and fall apart, a costly experience which has been repeated too often to leave doubt of the cause.

Maximilian Toch proposes as a remedy to paint the bars with a mixture of cement and water to insure a sufficient concentration of cement in contact with the iron. If then, due to imperfect mixture or otherwise the concrete is too lean, protection is still assured.

It is further pointed out that such a coating is inconvenient because it must be mixed and used immediately. Also, it does not stick to iron as a silicate solution does and there is danger of removing it locally as the bars are handled before the concrete is poured around them.

Two dipping vats, one filled with a sticky silicate diluted with water— the other containing dry cement to be dusted over the sticky surface, would yield an adherent coating to which the concrete would tie firmly. The process could be interrupted at any point, for the solution does not quickly deteriorate and dries very slowly or, in damp weather, not at all. As soon as the dry cement is dusted on the silicated surface, it adheres and sets to form a water resistant coating which retains a concentration of alkali ample to protect the metal.

# Concrete Sewer Pipe Manufacturing Plant of the Consumers Supply Co., Milwaukee

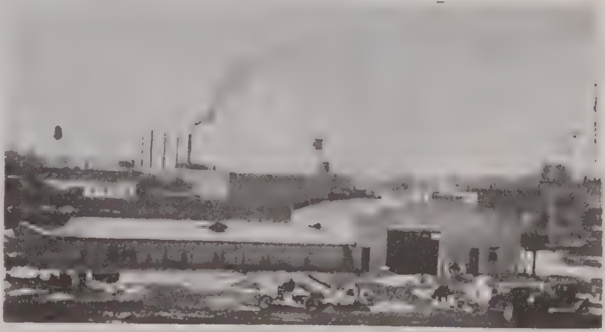
(*Contributed*)

The new pipe manufacturing plant of the Consumers Supply Co., Milwaukee, Wis., has attracted many visitors because it is an up-to-date plant built in the light of eight years successful manufacturing experience. It was in September, 1924, that the management decided upon a new plant in which 125 tons of pipe, all sizes can be turned out in a day. The average output is about 80 tons.

After eight years in the old location, a careful search was made for a new plant site that would give room for a large storage as well as ample facilities for manufacturing and still care for any possible expansion needed in the future. A plot was selected, having 6½ acres so located that it would require minimum haulage to the city and suburbs.

It might be worth while to sketch briefly the history of concrete pipe in Milwaukee. The old egg-shaped pipe used in Milwaukee, was hand-made there 35 to 40 years ago. It was successful as measured by standards of that day. In fact, many of those old pipe are still in service. With a background of concrete pipe as a guide, Fred R. Zimmerman, at present Secretary of State in Wisconsin organized a company to manufacture concrete pipe by machine methods. He interested three sewer contractors, George E. Zimmerman, W. T. Werner, and Herman Hohensee to join with him in this company which was incorporated under the name of the Consumers Supply Co.

At first it was planned to operate only a portion of the year and care for only the needs of the owners in their sewer work. Almost from the first this plan was abandoned. It was found that by having one price to all and quoting all bidders on the pipe required for a job, that better satisfaction resulted and a better feeling existed with the other contractors.



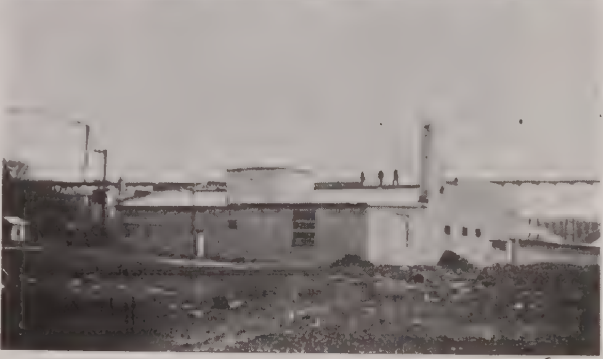


*Fig. 1 and 2—Exterior of the pipe plant*

For five years they manufactured about 5,000 tons per year in sizes from 6 in. to 21 in., inclusive, on a McCracken

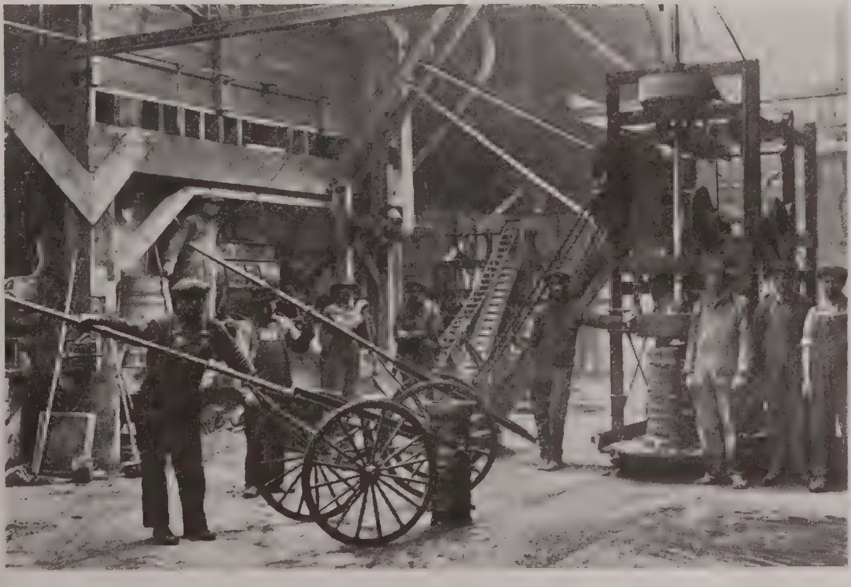


*Fig. 3—Interior view of the plant—two of the pipe machines*

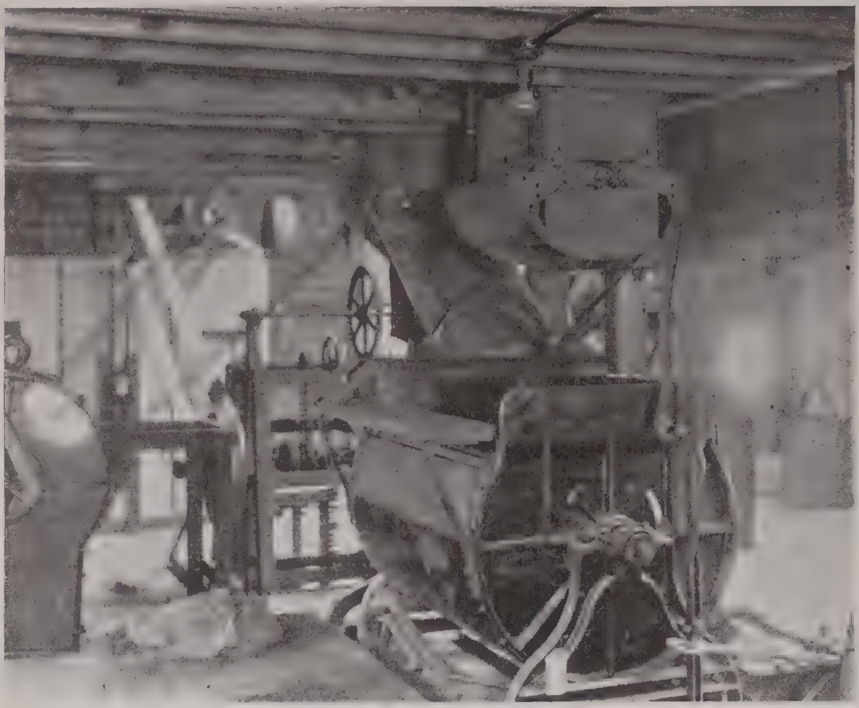


*Fig. 4—The mixing and measuring equipment*

machine and in larger sizes by the wet process. The latter were usually made on the job after the contract was awarded.

H. E. Brown, the present manager, took charge of the plant as general manager about 3½ years ago. He started at once to increase the number of customers and to give more careful attention to the uniformity and quality of the product. He was very successful in both attempts. Shortly afterward the Metropolitan Sewerage Commission established a testing laboratory and made periodic tests of the concrete pipe as well as of clay. This laboratory is also used by the Milwaukee Sewer Department until it can complete another testing laboratory.

Mr. Brown has had years of experience in the manufacture of pipe and other concrete products, and when the new location was decided on he quickly gave his architect all information needed to draw up suitable plans.

The site selected was occupied by eleven old houses of little value. The hardest part of the start was in persuading the tenants to move in less than the legal sixty days. This was accomplished and wrecking of the houses started. Five of the best were saved and moved to be used later as a warehouse. The others were given to a wrecking company for tearing down. The old basements presented a problem. It was very difficult for a contractor to estimate the quantities for a footing so the Consumers company decided to put in its own footings. After digging down to solid soil and placing enough concrete to make a footing, 12-in. concrete block were used to bring the wall up to grade. These blocks were laid up dry and the cores filled with concrete. This method was used to save time. While this was being done, trucks were filling the low places and leveling the grade. So thoroughly was this filling done, that no settlement has taken place although floors were laid on spots where the fill was as much as 7 ft. Plenty of water was used in settling the fills.

Building in a town where concrete block are so extensively used, Mr. Brown naturally specified block. In fact there is no masonry used in the plant that is not concrete except flue lining. More than 10,000, 20 in. x 9 in. blocks in widths of 8 in. or 12 in. were used, with Shope concrete brick for the chimneys and in filling in around rafters, joists, etc.

The plant faces north and consists of a work room 50 x 100 ft. The walls are 12 ft. high at eaves and made of 12-in. block. Steel lintels are used over all openings. There are no posts in the workroom, the roof being carried by four steel trusses. The cement room, a wing opposite the curing rooms has a capacity of 4,000 sacks of cement. There are five curing rooms, each 20 ft. x 100 ft. on the south side of the plant. These have a minimum roof height of 7 ft. and a maximum of 8 ft.6 in.

A large sky light over the entire workroom gives day light to all portions of the room.

Sand and stone are shipped in and dumped into a track hopper. A horizontal belt conveyor, designed and installed by the regular factory crew under the direction of Mr. Brown, conveys the aggregate to a bucket elevator likewise of their own installing. The belt conveyor carries the aggregate through a reinforced concrete tunnel under the cement bin a distance of 60 ft. The bucket elevator can hoist a yard of sand every two minutes to the 100-yard bin that is in the plant but extends through the roof. Fig 4 shows this bin in the plant. It also shows the 14-ft. Blystone mixer and the measuring spouts. These spouts were made by the Butler Equipment Co., Waukesha, Wis., designed for the plant. Both spouts are adjustable so that any desired mixture can be obtained. Spouts are fastened to steel channels that replace some of the floor joists. Since these pictures were taken, a water measuring tank has been added. This is marked in graduations so that a decrease in the amount of water required for a batch indicates the necessary increase in volume of sandspout to care for the bulking of sand when moistened. In pipe production, the consistency must be uniform so that any condition requiring more or less water quickly indicates a change in the moisture content of the sand. Behind the mixer is shown a Handy Sack Cleaner[1]. Sacks are cleaned as fast as they are emptied.

Fig. 3 shows two of the machines used. The one in the foreground is a McCracken[2], used for bell-end sizes from 8 in. to 21 in. inclusive. In the rear is shown a portion of the National pipe machine[3], used for sizes from 24 in. to 42 in. inclusive and is one of the new machines recently added. They have one more McCracken, not shown here, for making small sizes and connections. This machine also is used in the manufacture of conduit pipe. It is supplied with concrete by a smaller Blystone mixer.

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[1] Handy Sack Bailer Co., Cedar Rapids, Ia.
[2] McCracken Machinery Co., Sioux City, Ia.
[3] Quinn Wire & Iron Works, Boone, Ia.

A 70 h. p. Scotch marine boiler supplies the steam for curing. The heat thrown off from the curing room doors and from the boiler itself is sufficient to heat the plant workroom without additional radiation. The boiler and coal bin are at west end of workroom. The boiler easily maintained a temperature of 110° F. at the top of a pipe $2\frac{1}{2}$ ft. long in the curing room during sub-zero weather. The boiler[4] was especially made for this job.

The large pipe are made with diamond mesh reinforcement which works readily in the National machine. Recent tests show that greater strengths are obtained by making these sizes on a machine than by the old hand method. Milwaukee has some very strict specifications; they require pipe to pass the strength requirements specified in the 1924 report of Committee P-7 American Concrete Institute. These tests are being met and exceeded even on a 14-day test. Pipe of 48-in. inside diameter and larger are made by the wet method and are not carried in stock.

The proportioning devices used are so accurate and are watched so carefully that the daily variation in cement used for any given amount of pipe is less than 1%. Such accuracy results in very uniform product.

A careful watch is kept on the aggregate. The sand is a specially prepared size having a fineness modulus of 3.80. It is furnished by Janesville Sand & Gravel Co. of Janesville, Wis. The crushed dolomite is known as the $\frac{1}{2}$-in. size and is furnished by local companies. It too is carefully watched and frequently tested by sieves.

Because a regular floor or sidewalk contractor does not appreciate the extreme accuracy necessary for a perfect plane in the floors, all this work was done by the plant force.

The lighting in the curing rooms is all artificial and cared for by rubber covered extension wires on a copper wire suspension. Double doors are provided on these rooms to prevent loss of steam and heat. The inside of the roof is thoroughly creosoted.

Cold weather makes but little difference here. In good weather a car of aggregate is unloaded in one and one-half hours. If the sand is frozen, a steam extension pipe thaws it out quickly. After the aggregate is elevated, it is thoroughly thawed by steam. A careful construction of the sand bin permits the excess room heat to pass up and over the aggregate, keeping it well warmed. Provision has been made for storing excess materials outside the plant so it can be again elevated into the bin.

The plant is equipped to ship pipe to other towns too far away for truck haul. A depressed track permits quick loading of railroad cars while trucks are loaded by a portable derrick. This derrick is also used for piling pipe that is being aged in the yard.

Mr. Brown has always welcomed inspectors if they care to be at the plant during the making of pipe. Every pipe is dated and the mark of the company placed on it as soon as the jackets are removed so that the city officials or any one else can tell at a glance the date and maker of pipe.

The Sewerage Commission permits Mr. Brown to use its testing machine for any comparative date that he wants to guide him in the purchase of aggregates or other information that he wants to aid him in the manufacture. He has his own Hydrostatic machine for making other tests if desired.

The design of the plant has provided for any future expansion that is needed. At present the plant can turn out and cure four car loads of pipe daily. There are so many calls for pipe from engineers and dealers that they expect to put on a sales engineer in the near future to handle outside sales. A large stock will be carried to insure prompt service.

As to labor, a working day is 9 hrs. Actually the hours of labor on pipe would be about 8 hrs. and 25 min. Practically all factories pay for 9 hrs. They donate 20 minutes time to the men for lunch at 9:30 a. m. and allow 15 min. at night for cleaning up. The plant has a foreman who watches the concrete, workmanship on pipe, and fills in if a man must leave his duty for a short time. There is also a mixer man, machine man and helper, two wheelers to wheel the pipe to the curing room, one man to feed elevator and one man to remove jackets from pipe. A crew of eight men will operate either of the larger machines. The company keeps a mechanic who cares for boiler, does repair work, oils, greases and fills in. He also helps two other men used in taking out cured pipe and in loading trucks or cars. The bookkeeper also spends part of his time during the slack months of winter and when not busy in summer, in helping where needed. It is possible for the mechanic to look after practically all unloading of aggregates.

If there is considerable outside work to be done, a part of the crew—not over four men—will operate the small machine on special or conduit pipe. On days when weather is bad the regular outside crew will come in and work on this machine.

In real busy seasons a crew of 18 or 20 men is employed while in a normal period there are but ten men in addition to foreman and mechanic who work by the month. With this small crew, work is alternated on the larger machines, thus giving extra curing time for the product.

In operating the big machine one man is needed to cut and fasten the reinforcement. If the curing rooms to be emptied are filled with 30-in. and larger pipe, which are made in 3-ft. length, two men cannot turn the pipe over preparatory to rolling out. Therefore, the whole crew does this work and gets all the pipe turned over. They use four or five old automobile casings to tip the pipe on, these serving as a cushion to prevent breakage.

Recently two of the men who live near the factory have contracted to unload all cement received. They go home at 4:30 p. m., the regular quitting time, eat a lunch and return at 5:15. By 9:00 they have the cars unloaded. They receive 3c per bbl. for this, or about $6.00 per car, depending on the size.

A commercial trucking firm is employed by the hour for local deliveries so it is expedient that they be assisted in loading rapidly.

Pipe are sold on a narrow margin of profit, volume of sales being depended upon to pay dividends rather than a big profit from few sales. Visitors are always welcome.

## To Save Masonry From Deterioration

Twelve years ago much of the stone work about the Metropolitan Museum of Art, New York City, showed signs of deterioration due to the wear of the elements and Dr. William Kuckro, then chief chemist of the Museum, after considerable laboratory experiment, evolved a method of treating masonry to protect it from dampness and other weathering.

The method consisted of the application, by brush or spray, of a void-filling liquid devoid of acids or alkalis. The material perfected by Dr. Kuckro, which is now being placed on the market by the Kuckro Chemical Co. under the trade name Dampex, is light, colorless and inflammable. The first coat coverage of a gallon is 300 sq. ft., second coat, 500 sq. ft. It may be applied successfully to surfaces of concrete, brick, natural stone, stucco or wood. It dries in an hour, and is said to withstand any climate. When mixed with paint it replaces linseed oil or other thinner and does not oxidize.

Its successful use at the New York Museum, led to its use at the Military Academy at West Point, the Obelisk, Central Park, New York, Swedish Hospital, Brooklyn, National Museum, Washington, D. C., Government Storage Warehouse Mill Island, N. Y., University Museum of Pennsylvania, Philadelphia, and many other important structures.

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[4] Schwab-Lezotte Co. Milwaukee.

# Manufacture of Supertile

A new type of equipment and new operations in making concrete masonry units are involved in a plant in operation in Redlands, Calif., built by the Concrete Products Mould Co., which has been succeeded by the Supertile Machinery Corp. Stephen Flam is the inventor.

The unit manufactured is a lightweight tile generally 4 in. high, though it can be made in other heights. The length is 12 in. The widths are 4, 6 and 8 in.

A large pallet to accommodate 24 of the 4-in. or 16 of the 6-in. or 12 of the 8-in. tile is placed on the portable machine, of which the cores are a part. The mold is put on for filling and removed for stacking (Fig. 1). The cores come up through the bottom of the pallet. Side walls and division plates are applied to form a mold on top of the pallet. Concrete having a consistency which gives it a slump of ½ in. is discharged from a mixer to a slanting table and from there raked into a mold where it is tamped by the narrow steel fingers of a rake. The surplus material is removed and the stacker with its bracket supports on a Barrett lift-truck, is wheeled into a steam room where the five decks of loaded pallets are slid onto racks.

Two and one half hours after the tile have been placed in a steam room they are removed by a lift truck which handles five pallet loads at a time and wheeled over concrete runways to the yard. They can be stacked at that age 5 ft. high. The pallets and mold pieces are used three times each day.

One man is used at the mixer, two men at the mold and two men on the lift truck emptying the molds and stacking the tile. This 5-man outfit makes 3000 to 3500 per day.

The labor cost is considerably reduced by the addition of a second stacker. This adds one man on the manufacturing end and one man on the discharge end so that seven men will make about 6500 tile per day.

The designers of the Redlands plant have been in the concrete tile industry for years; and before work was begun on this unit, it was attempted to eliminate all unnecessary steps, to render progress rapid and to require materials to travel as short distances as practicable. Hence the plant is laid out compactly and the processes of manufacture are almost entirely accomplished mechanically.

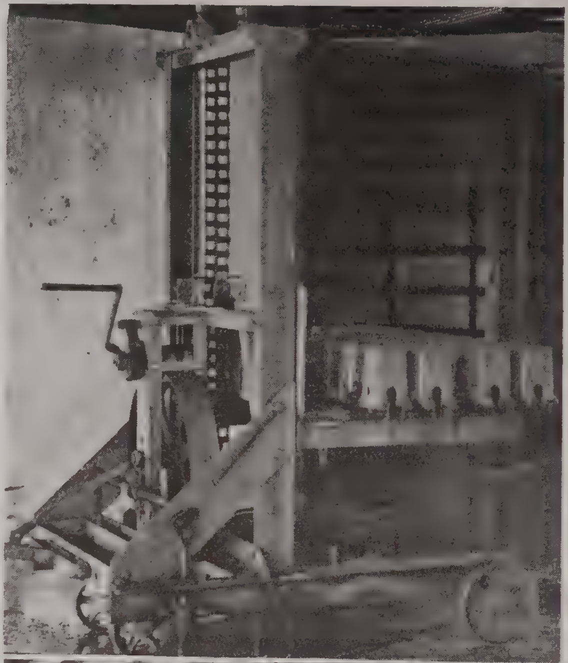
There is a railroad spur track on which sand, gravel and cement are delivered, the sand and gravel are dumped from the cars into the pit and from there elevated by a hopper to the concrete mixer, the mixer being at some height above the working floor of the plant. Batches of wet concrete are dumped from the mixer to a table and from there dragged into the steel forms, which are supported upon the platform of the machine.

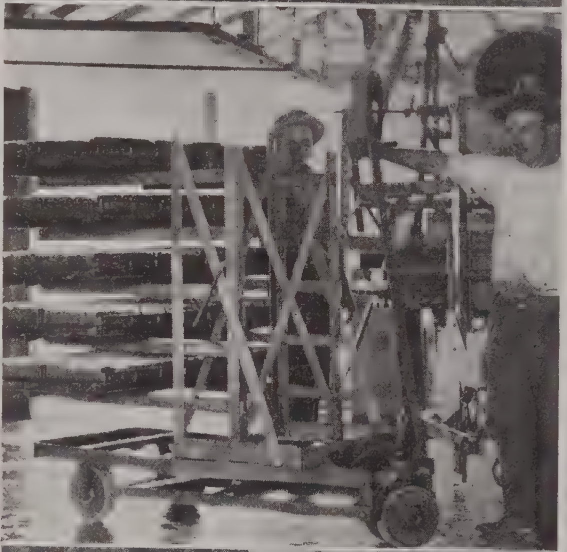
The concrete is agitated by a light tamper in the hands of the two men at this point. The machine may be wheeled to one of the curing tunnels where the platform is lowered until the forms rest on the angle irons built in the walls of the tunnel as shelves, and the cores slide out of the forms leaving the tiles in place for curing and the stacker with cores ready for the next form-plate or the machine may transfer its load, a deck at a time, to the racks of the left truck. This process is repeated until the five shelves of the tunnel are loaded.

To take the tiles from the tunnels, the lift-truck is used again. One man lifts five form-plates at one time from the shelves and takes them out to the yard; here the forms are taken apart and the tile placed where they are to remain till shipped to the job. Tile are picked up manually only once throughout the entire process of manufacture.

The time of set for the concrete is hastened by the use of live steam of 10 lbs. pressure, released through perforated pipes in water troughs built in the tunnel floors.

The manner in which the arms on the superstructure of the lift-truck can be slid back out of the way is worthy of note, also the fact that the entire superstructure can be taken from the lift-truck in a moment's time by merely disengaging a handle, which may be seen in the picture at the bottom front of the framework.





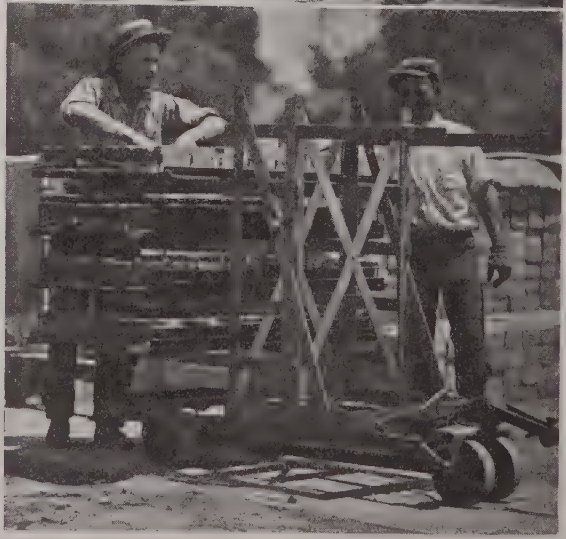


*Fig. 1—The portable molding machine*
*Fig. 2—The lift truck with five deck loads*
*Fig. 3—The lift truck load is discharged in the yard*

# Tests of Alumina Cement

*A Letter from J. Y. Jewett*

TESTING ENGINEER, CITY OF SAN DIEGO, CALIF.

The article[1] in the April issue of CONCRETE describing tests of alumina cement (of the Atlas Lumnite brand) made at the University of Michigan, is of interest as adding to the store of information being accumulated on that material.

Results of recent tests made by the writer conform in general to those reported in this article, and by other investigators, in bringing out the significant features of very high early strength and also of high ultimate strength attained by cements of this type. The writer's tests also confirm the claim made that low temperature conditions do not materially affect the setting and hardening properties of this cement, as is the case with portland cement. In compressive strength tests on standard 6 in. x 12 in. concrete cylinders (1:2:4 mix) the results under ice-box storage at 38° F. were 94.9, 92.4 and 94.1%, at 1 day, 7 day and 28 day periods, respectively, of those on similar specimens stored at normal laboratory temperature.

One point which seems deserving of further discussion is brought up in the paragraph in this article which states that—

"Absence of moisture during the curing period seems to have much less effect on aluminate cement than upon portland cement. In fact, in almost every case the cylinders cured in dry air were stronger than those cured in moist air, the average difference in strength being 7%."

The writer's experience indicates a tendency toward a porous surface condition in concrete made with this cement. In an attempt to determine whether this cement is more resistive than portland to changing moisture and temperature conditions, some small mortar slabs, and slabs of concrete with mortar coating, were made up, and placed under observation, and it was noticed that those made with the alumina cement seemed to absorb water more readily than those made with the portland. Some large pats of neat cement were then made, for further observation in this respect. Kept continuously in air, the Lumnite pat was much more porous than the portland, absorbing water like a sponge. Kept in moist closet for 6 hours, then immersed, Lumnite was similar to portland kept in same storage for the usual 24 hours and then immersed—this being after removal from immersion at end of 7 days. Lumnite kept continuously in the moist closet was intermediate between the other two.

While as stated in the above quoted paragraph, lack of moisture for curing may not materially affect the compressive strength, it does seem that this is a point which should be given attention in cases where surface porosity and water absorption are important factors. It appears also that the curing moisture should be supplied at a period beginning about 6 hours after mixing, or at about the end of the period of "initial set."

It is suggested that further investigation of this feature would be desirable.

# Quantities of Materials for Concrete

A second edition of Bulletin 9 of the Structural Materials Research Laboratory, Lewis Institute, Chicago, *Quantities of Materials for Concrete*, by Duff A. Abrams and Stanton Walker, has been issued.

The principal subject-matter of the Bulletin is a series of tables of proportions and quantities for portland cement concrete for compressive strengths of 2000, 2500, 3000, 3500, and 4000 lb. per sq. in. at 28 days, using fine and coarse aggregates of different sizes, and concrete of a wide range of workability as measured by the slump test.

The tables are based on the water-ratio method of proportioning concrete developed in the Structural Materials Research Laboratory as a result of many thousands of tests. They differ principally from tables by other authors in that the proportions have been selected with definite strengths in view, and take into account the quantity of mixing water as well as the size and grading of the fine and coarse aggregates.

This Bulletin was first published in 1921, but had been out of print for several months. In the second edition, the text has been rewritten to constitute a more complete discussion of the subject. A method of taking into account the differences in volumes of materials when measured in the Laboratory and when measured under field conditions is described. The descriptions of field and laboratory test methods have been enlarged and include recent changes in the Standards of the American Society for Testing Materials.

# The Adhesion of Gypsum Plaster to Backings

The Bureau of Standards has completed an investigation relating to the adhesion of gypsum plaster to all of the various backings commonly employed in practice. Although the art of plastering has been known for many centuries, a search through the literature discloses a complete lack of information on the subject of adhesion of wall plasters. Therefore, when a new material appears on the market to be used as a backing for plaster there is no information available as to the adhesion required of it. In order to supply this information, tests were made on the adhesion of gypsum plaster, a representative wall plaster, to all of the backings commonly used in practice. It is now possible to compare these data with the results obtained with any new material, and in this way the value of the new material as a backing can be ascertained in so far as adhesion is concerned. The gypsum plaster was applied to specimens of the various backings, and after the plaster had been allowed to age for seven days it was pulled free of the backing. The force required to rupture the bond was determined and recorded.

The kinds of backings employed may be divided into two general types (1) masonry, and (2) laths. Each of these types included many varieties. Backings tested were plastered with the recommended sanded-mixes of gypsum plaster of about ¾-in. grounds. The plaster was retarded so as to set in about four hours.

The size of the specimens of the various backings was about 12 x 14 in., and the area of the plaster was about 9 x 9 in. Embedded in the plaster was a mechanical device through which a force could be applied to pull the plaster from the backings. At the completion of the aging period, the specimens were put in a testing machine and a continually increasing force was applied to the device until the bond between the plaster and backings ruptured

The results obtained in these tests show that there is a great difference in the values for the adhesion of gypsum plaster to different kinds of backings, there being also a wide range of values within each type. The results show very strikingly that the tenacity of adhesion depends to a large extent upon the character of the surface to be plastered. In the case of brick and tile it was found that the roughest side of the brick wall or tile offered the better mechanical key and gave the greater adhesion. On the other hand, the porosity or total absorption of the brick or tile does not seem to govern the adhesion.

Assuming the weight of a ¾-in. plaster coat at 6 lbs./ft.$^2$ it was found that the factor of safety of any of the backings tested was relatively high. A detailed report of the work is being prepared for publication.

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[1] "The Properties and Use of Aluminate Cement" by Roger L. Morrison.

# Proportioning for a Given Compressive Strength at 28 Days*

Present-day practice in commercial concrete operations tends toward the specifying of concrete by strength for a given supply of materials, rather than the specifying of definite proportions which through long experience may be expected to furnish a concrete of the desired strength at 28 days. In order that the bureau might have laboratory data on the present methods of proportioning the ingredients to give a definite strength at the 28-day age, a limited series of tests was carried out.

Three sands (O–No. 8, O–No. 4, and O–⅜) and three sizes of pebbles (No. 4 to ¾ in., No. 4 to 2 in., and ⅜ to 1½ in.) were included in the work. Each sand was combined with each size of pebbles, in eight different proportions. Three different slumps were used, ½ to 1 in., 6 to 7 in., and 8 to 10 in. The 72 mixes are found on pages 10, 12, and 14 of Bulletin 9 of the Structural Materials Research Laboratory under the sizes of aggregate and slump here given.

For each mix, five companion 6 x 12 in. test cylinders as nearly alike as possible were made, each on a different day. In all 360 cylinders were made. The specimens were cured under damp storage conditions and tested when 28 days old. The cement used in the tests was of a standard brand meeting the Government requirements, and the aggregates were washed Potomac River sand and pebbles.

The ratio of volume of water to volume of cement in a mix has been found to offer a fair index of the strength. The expression 14,000, divided by 7 raised to a power equal to the water-cement ratio, has been proposed by the Structural Materials Research Laboratory for determining the strength, and seems to be used to a considerable extent in practice for this purpose. This expression has been used as a criterion for studying the results of these tests.

It was found that mixes in which the quantity of aggregate which passed through a No. 4 sieve was less than one-third of the total aggregate, as well as the mixes in which the quantity of coarse aggregate of some one size was less than one-third as great as the quantity of aggregate twice as large, generally gave strengths less than that shown by the expression used as a criterion. If the mixes referred to be eliminated, all the remaining mixes gave strengths as great or greater than the criterion. In determining the quantity of coarse aggregate of different sizes, the aggregate was screened on a set of screens whose mesh opening advanced in size by multiples of two from the opening of a No. 4 sieve (0.094 in.) to an opening large enough to admit the largest aggregate. The amount of aggregate between any two consecutive screen sizes is referred to as of one size, and each size was considered to be twice as great as the next smaller size.

So far as these tests indicate, it may be concluded that the expression 14,000, divided by 7 raised to a power equal to the water-cement ratio, is a fair measure of the strength of concrete, provided that at least one-third of the aggregate is sand (that is, smaller than a No. 4 sieve) and that the quantity of coarse aggregate of any one size is not less than one-third as great as that of the next larger size.

Other tests not included in the investigation indicate also that the sand should not be more than half the total aggregate in order to meet this criterion.

United States Department of Commerce has issued Simplified Practice Recommendation No. 26 on the elimination of waste in steel reinforcing bars, showing a reduction from 32 to 11 areas of steel reinforcing bars corresponding to an elimination of 65.6%.

# Competitive Bridge Designs for Norway

The Municipality of Drammen in Norway invites Norwegian and foreign engineers and architects to compete for the design of a new bridge across the river of Drammen, between the two neighborhoods Bragernaes and Stromso. A pamphlet containing a program of the competition may be obtained upon application to the Bureau of the Government Engineer, (Statsingenior-kontoret), at Drammen.

Competitive designs should be addressed in sealed envelopes to the Government Engineer, Drammen, Radjusgaten, 9, and should be deposited at the above address before October 1, 1925. The judging in the competition will be effected according to the rules of the Norwegian Engineers' Association as regards engineering competitions of November 5, 1918.

The following prizes are offered for the best designs: 1st prize, 10,000 Norwegian crowns; 2nd prize, 8000 and 3rd prize, 6000 Norwegian crowns.

The right has been reserved to buy designs not winning awards for the amount of 3000 crowns each.

# *Organizations*

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Committee; Dr. P. G. Agne, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High Street, Columbus, Ohio.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., New York City.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.

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*From Technical News Bulletin, U. S. Bureau of Standards.

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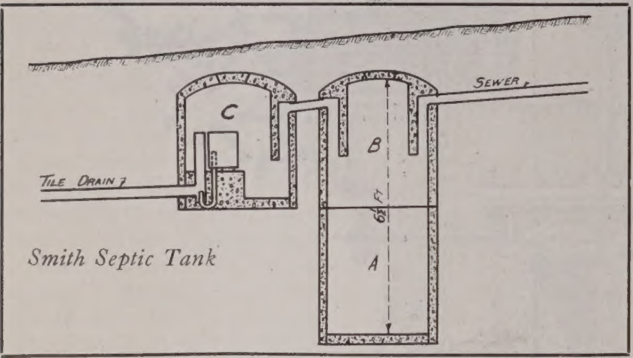
## Smith Septic Tank

T. A. Smith, Smith Construction Co., Paw Paw, Mich., has designed a septic tank, shown in cross-section in the accompanying illustration.

Referring to the diagram, A represents a concrete tile 3 ft. in diameter, by 3½ ft. long. B is a unit of the septic tank made in forms built by W. DeLhorbe, Oregon, Ill. C is a similar tank with a siphon built in to provide intermittent discharge of effluent to the tile drain system.

"The three units are made and kept on hand at my concrete products plant," writes Mr. Smith. "All three pieces can be made from the same form by slight alterations. Tank C is made in two parts, the siphon being set up and cast in concrete; then the tank is placed over it and the two cemented together. The siphon is built according to specifications given in special bulletin No. 119 of the Michigan Agricultural College, Farm Mechanics Station.



*Smith Septic Tank*

"The procedure of placing a tank is as follows: Dig a hole 4½ ft. deep, 4 ft. wide and 7½ ft. long. Set the tile in the end toward the sewer. Dig out from inside the tile, sinking it until its top is flush with the bottom of the hole. Put a concrete floor in it. Place mortar around the top edge and set B, then C, connecting them with a piece of 4-in. sewer pipe. A 2-in. pipe tripod and chain hoist are used for setting B and C.

## Truck Load of Block Handled on a Pallet

The picture shows how McCrady Bros. Co., Braddock, Pa. haul and deliver in a neat pile, a load of concrete block. This is Fontaine demountable body equipment (made by the American Truck & Body Co., Martinsville, Va.) The block are piled on a pallet at the plant so as to conform to the special truck body. Thus only one truck body serves and picks up a load at one lift, pallet and all. It requires about three minutes to make the necessary attachment to pick up a load. It requires about three minutes to unload and detach. The load is set down as one unit without jar.

*Hoist raising load of concrete block on pallet*

## New Ransome Tilting Mixer

A new 3½-S tilting mixer has just been put out by Ransome Concrete Machinery Co., Dunellen, N. J., which differs from other machines of this type chiefly in the use of Timken tapered roller bearings on the spindle and the absence of castings in the truck assembly. The mixer is mounted either as the trailer type, in which it is mounted on two rubber tired wheels with coil springs between the axle and the frame, or the truck type where the mixer is mounted on 19-in. steel wheels.

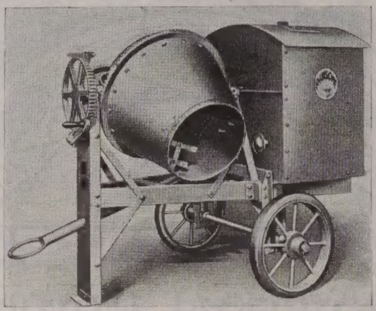


*Fig. 1 — Ransome 3½-S tilting mixer*

Among the advantages claimed for this mixer are the good mixing action due to double slat blades and anti-balling blades mounted in the base of the drum. The drum can be charged or discharged from either side.

## Ford Runabout with Pick-Up Body

Announcement is made by the Ford Motor Co. of a new light trucking unit, a standard Ford runabout with rear deck replaced by a pick-up body. This makes available an all-steel body, securely attached to the frame of the chassis, with rear door adjustable chains, side flanges, and steel floor strips with sunken bolt heads. The inside dimensions of the body are 40¾ in. by 56 in. Height from floor to top of flare is 13 in.

## Trade Publications

*Textone* is the title of another United Gypsum publication in which a similar careful exposition is made of the more recently developed ideas in interior plaster finishes which are so rapidly displacing wall-papers.

The United States Standard block machines, concrete mixers and power tampers, form the subject matter of a very attractive catalog issued by the United States Standard Manufacturing Co., Columbiana Ohio. This is catalog No. 5 and devotes 48, 6 x 9 in. pages to illustrations and text describing in detail the machines and their parts in the Standard lines.

The Alexander Milburn Co., Baltimore, Md., has just issued two miniature catalogs, *The Milburn Light* and *Milburn Welding and Cutting Apparatus*, descriptive of portable carbide lights for night construction work and welding and cutting apparatus, from a small torch to a large compressing plant.

The Federal Cement Tile Co., Chicago, Ill., has issued *Roof Standards*, a 32-page book which has been prepared carefully after several months of consideration. The book which is 8½ in. x 11 in., for standard filing, contains, besides complete general roof tile specifications and specifications covering the various types of Federal cement tile, 26 pages of detailed drawings showing the application of precast reinforced concrete slabs for all types of roof construction. There is also a page on grandstand seat deck construction. Much detailed information of interest to readers who are interested in precast reinforced concrete slabs is contained in this book.